ORDNANCE

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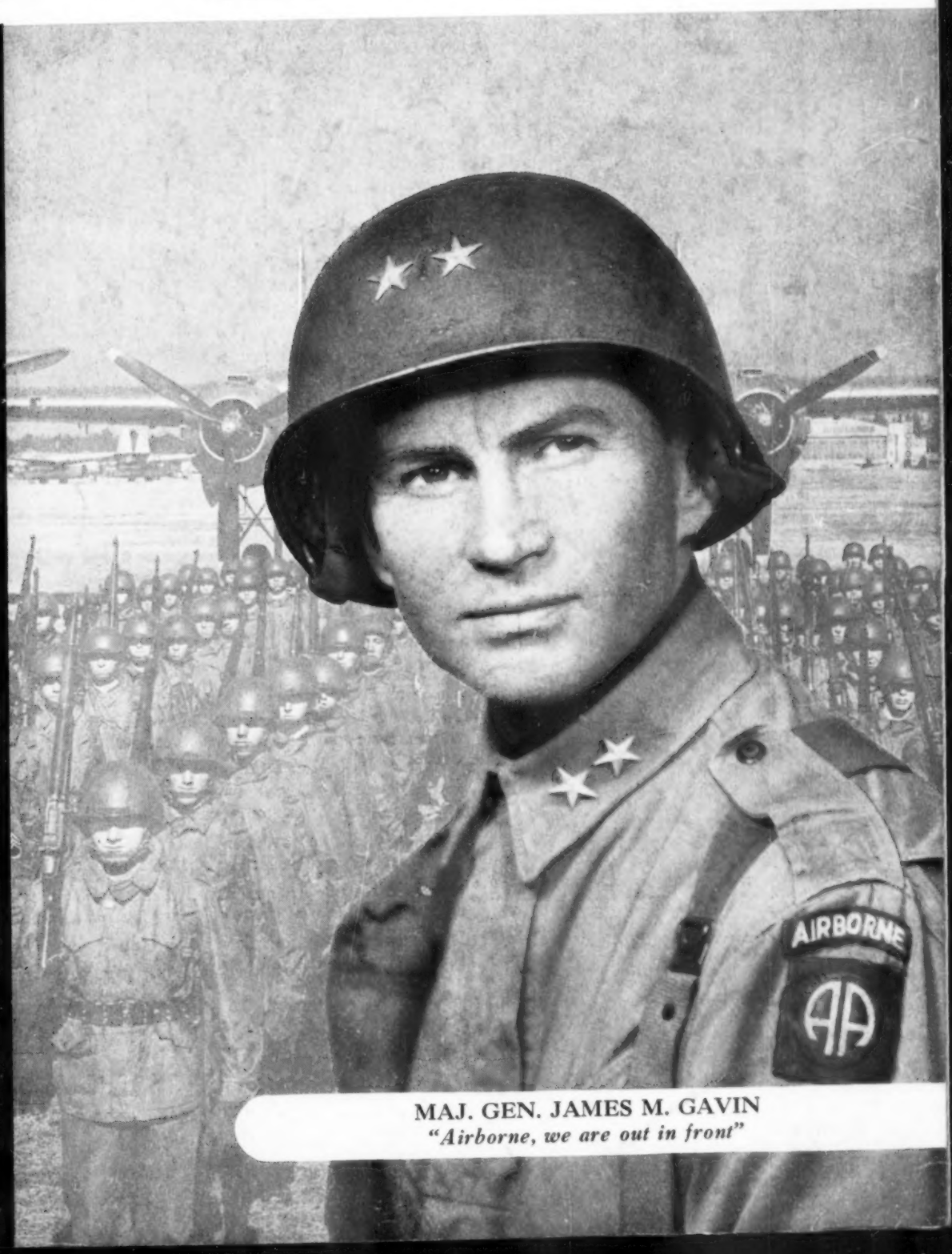

MAJ. GEN. JAMES M. GAVIN
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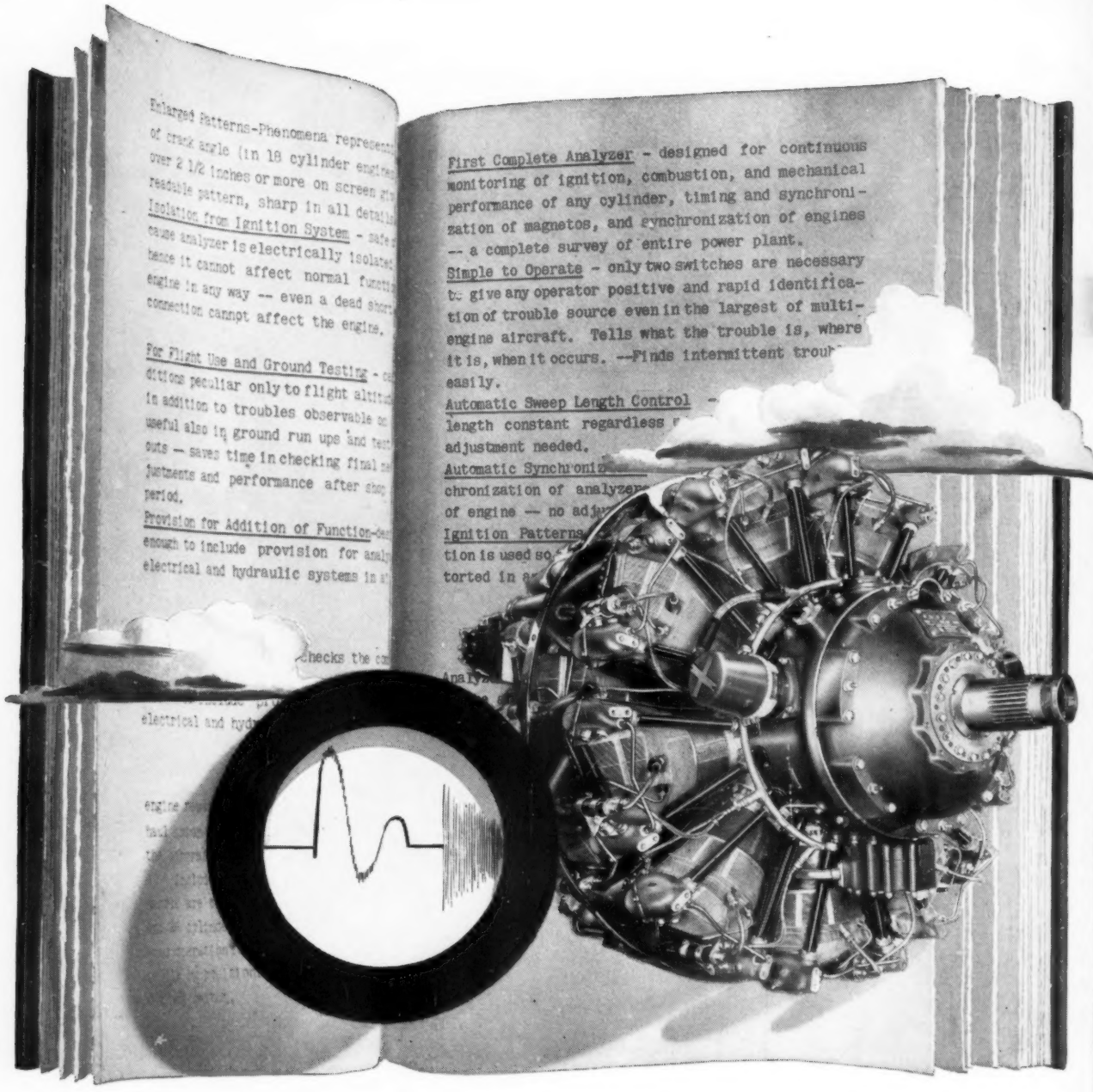
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ORDNANCE

THE JOURNAL OF THE AMERICAN ORDNANCE ASSOCIATION

FEATURES

Flying Infantrymen		Frontispiece
Attack by Air		89
Why Preparedness?	James L. Walsh	90
Simplify for Production	Maj. Gen. Everett S. Hughes	91
Weapons and the Navy	Rear Adm. A. G. Noble	92
Ordnance Electronics	Donald A. Quarles	93
The Guided Missile	Dr. C. F. Green	96
Ground-to-Air Defense	Preston R. Bassett	99
Posts of the A.O.A.	Herbert A. Gidney	102
Undersea Warfare	Rear Adm. C. B. Momsen	104
Airborne Warfare	Maj. Gen. James M. Gavin	106
Ordnance Day, 1948		109
For the Common Defense	Victor Sifton	113
A Plan for Air Power	Gen. Joseph T. McNarney	115
The Navy-Army Air Team	Vice Adm. John D. Price	117
The State of the Army	Gen. Omar N. Bradley	118
Armament and Production	K. T. Keller	120
Oil and Defense	L. A. Codd	123
Month by Month		126
Spadework for Survival	James L. Walsh	128

DEPARTMENTS

Association Affairs	129	Atomic Energy	132
The National Divisions, A.O.A.	131	Book Reviews	134
		Index of Advertisements	147

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• This issue of ORDNANCE is devoted to the entire proceedings of the Thirtieth National Meeting of the American Ordnance Association held at the Book-Cadillac Hotel, Detroit, Mich., on June 9th and at Selfridge Air Force Base, Mich., on June 10, 1948.

The addresses delivered at the Ordnance Technology Round Table are published on pages 90 to 101, inclusive, and those given at the Industrial Preparedness Luncheon appear on pages 102 to 108, inclusive.

An illustrated account of the demonstration of tactics and matériel for land, sea, and air warfare which was held at Selfridge Air Force Base will be found on pages 109 to 112.

The addresses given at the Thirtieth National Dinner Meeting at the Book-Cadillac are published on pages 113 to 119, inclusive.

• The National Headquarters staff of the Association is grateful to all the officers, members, and guests who helped make the Thirtieth National Meeting a success. All who attended the sessions are especially grateful to Harvey C. Knowles, vice-president of the A.O.A. in charge of National Divisions, for his splendid work in presiding at the Ordnance Technology Round Table, and to Robert L. Biggers, president of the Michigan Post, A.O.A., for his efficient services in presiding at the Industrial Preparedness Luncheon and at the Thirtieth National Dinner Meeting; also for his dynamic efforts in arranging many of the local details of the meeting.

• This issue of ORDNANCE is printed in two sections. The second section contains the Honor Roll of Industrial Preparedness which lists the names of nearly 700 Company Members of the A.O.A. who are coöperating in our efforts to effect scientific and industrial preparedness for security and peace.

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A.O.A. DIVISIONS AND COMMITTEES

ONE of the principal functions of the American Ordnance Association is "to provide, when required, the services of competent committees to investigate and report upon special ordnance subjects and to encourage programs for the adequate understanding of the procurement, production, and other untold phases of national preparedness including those new developments of logistics necessitated by modern military strategy and tactics."

To meet this obligation to our national defense, the Association has in operation a number of National Divisions under the leadership of civilian experts who are well qualified to direct their activities. In addition, there are a number of committees on special subjects, some of which are of a continuing nature. Others for the performance of a specific undertaking are noncontinuing. All are devoted primarily to the advancement of engineering practices and production techniques relating to particular fields of ordnance.

Section 25 of the Association's by-laws provides that: "Each Division shall be under the direction of a committee to be selected by the Board of Directors. Through meetings, conferences, and discussions, and in coöperation with local Posts, they shall keep the membership in close contact with ordnance programs in particular fields. They shall meet as Divisions from time to time and shall be available in an advisory capacity for such matters as may be presented for their study and report either by the armed forces or by the Association."

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In either case, let Arnold's engineering service help you to find the answers to your magnet problems. Arnold offers you a fully complete line of permanent magnet materials, produced under 100% quality-control in any size or shape you require, and supplied in any stage from rough shapes to finish-ground and tested units, ready for final assembly. Write direct, or to any Allegheny Ludlum branch office.

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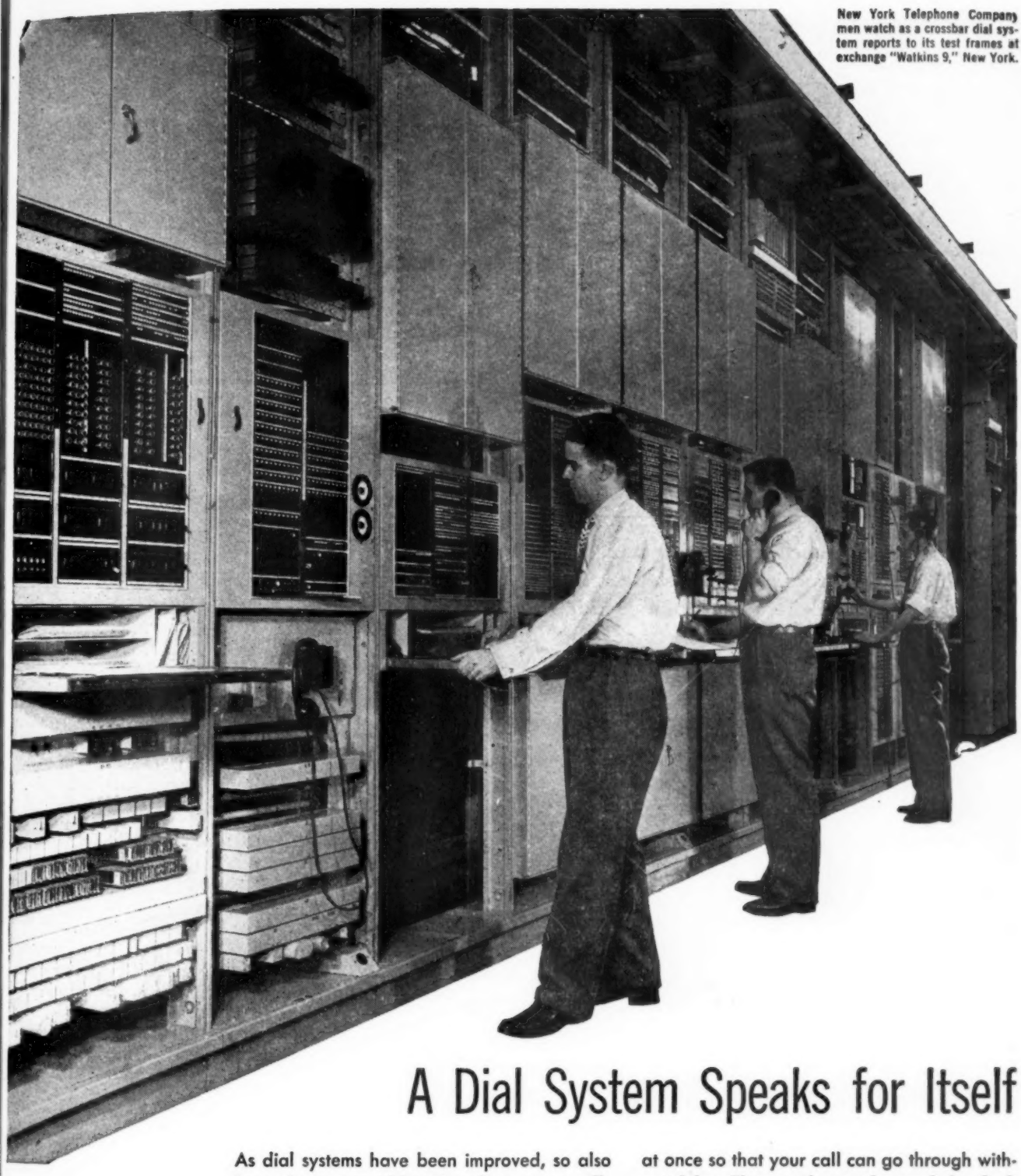


New York Telephone Company men watch as a crossbar dial system reports to its test frames at exchange "Watkins 9," New York.

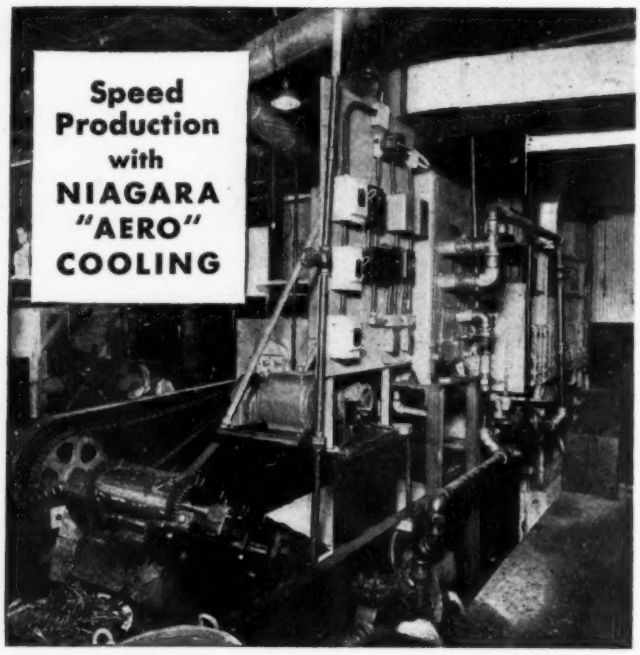
A Dial System Speaks for Itself

As dial systems have been improved, so also have the means of keeping them at top efficiency. Even before trouble appears, test frames, developed in Bell Telephone Laboratories, are constantly at work sending trial calls along the telephone highways. Flashing lamps report anything that has gone wrong, and the fault is quickly located and cleared.

If trouble prevents one of the highways from completing your call, another is selected at once so that your call can go through without delay. Then on the test frames lights flash up telling which highway was defective and on what section of that highway the trouble occurred.

Whenever Bell Laboratories designs a new telephone system, plans are made for its maintenance, test equipment is designed, and key personnel trained. Thus foresight keeps your Bell telephone system in apple-pie order.

BELL TELEPHONE LABORATORIES *EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE*



This compact quench bath cooler increases production by furnishing ample cooling capacity for the highest speed of a continuous heat treating process. More important, it increases the net production result by preventing loss from rejected pieces. It maintains the specific temperature uniformly, removing heat at the rate of input. Also, it can automatically add heat at the start of a run to prevent loss during a warm-up period.

The NIAGARA AERO HEAT EXCHANGER is made in a wide range of sizes to handle any cooling load. It replaces both shell and tube cooler and cooling tower and its water saving repays its cost in a short time.

Other applications include jacket water temperature control for process equipment or engines, cutting oils, lubricants, hydraulic oils, transformers, electronic sets, controlled atmospheres, compressed air or gas cooling.

Write for Bulletin 96-0

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INDUSTRIAL COOLING HEATING • DRYING

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HUMIDIFYING • AIR ENGINEERING EQUIPMENT

New Developments

LAND

NEW ARMY EQUIPMENT

Much new equipment, ranging from a new, lightweight, fully automatic rifle to revolutionary new reducing pills, and from a new light tank to pocket warmers in new Arctic clothing, will begin to filter into Army units within the next few months. New ordnance items include the following:

A rifle, lighter than the Garand M1, which, according to Maj. Gen. Everett S. Hughes, Chief of Army Ordnance, "eventually" will replace the Garand. The new rifle, a caliber .30 like the M1, is fully automatic while the M1 is semiautomatic.

A new light tank, the T37, with highly efficient and automatic fire-control system.

A modernized M26 tank.

Modern transport vehicles including T80 armored carriers to carry the infantry along with the tanks. The proximity fuze will make it dangerous for troops to ride the tanks in any future operation.

Antiaircraft directors with trackers, for protection against new, high-speed jet and other planes. These are of particular importance as a defense against suicidal airplane attacks.

INDUSTRIAL AUTHORITY

Secretary of Defense James Forrestal has issued a new directive to the Munitions Board delegating to the Board all his authority relating to industrial matters in the National Military Establishment, and establishing a new administrative organization for the Board's staff. By the terms of the directive the Munitions Board is given general responsibility "for coördinating all policies, plans, and activities of the National Military Establishment relating to industrial matters, including procurement, production, and distribution plans of the departments and agencies comprising the Establishment."

SYNTHETIC FUEL SURVEY

Lieut. Gen. R. A. Wheeler, Chief of Engineers, has announced the award of a $110,000 contract which initiates a nationwide survey to be conducted by the Corps of Engineers at the request of the Department of the Interior as a part of the latter's program to procure the basic data necessary for the planning of synthetic fuel manufacturing plants.

HIGH-SPEED PHOTOS

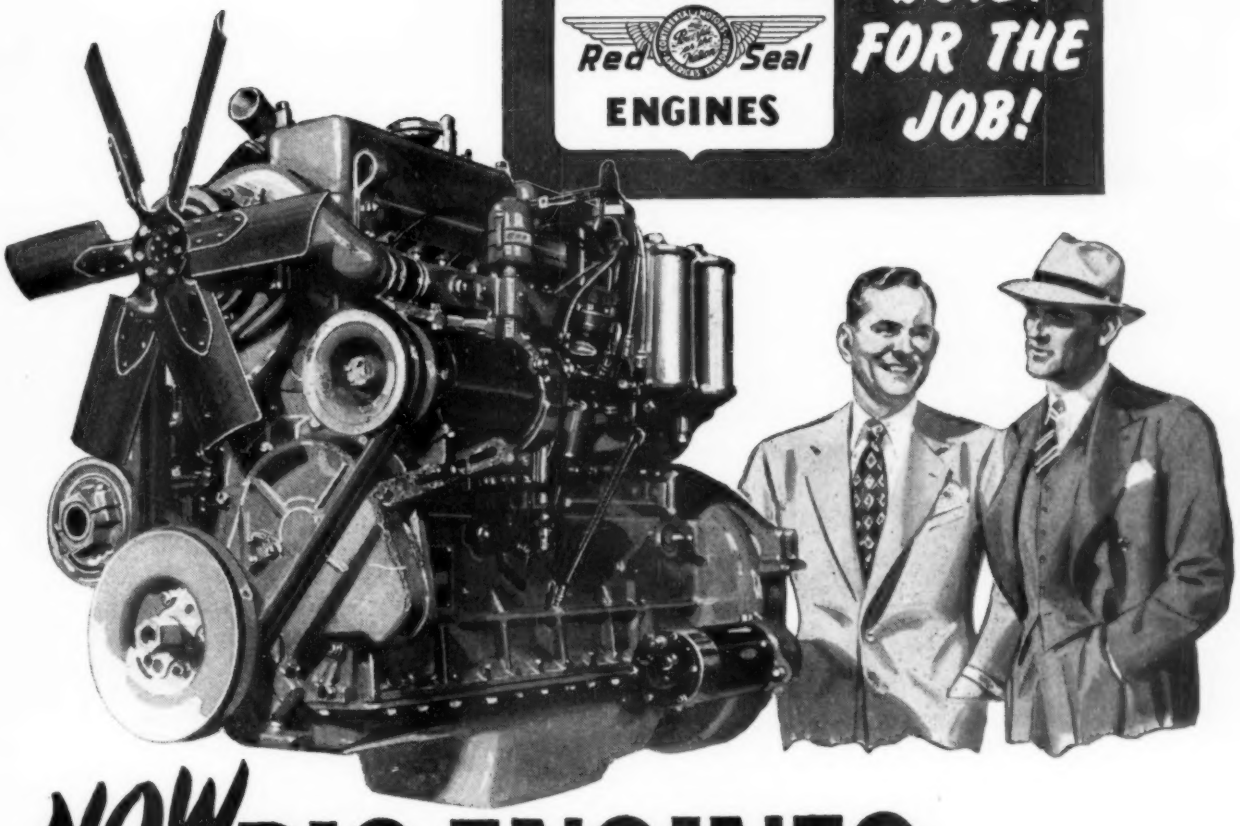
New high-speed photographic equipment for catching the image of objects moving far faster than sound has been developed by the General Engineering and Consulting Laboratory of the General Electric Company. A flash of light, lasting only two-millionths of a second, throws enough bright light on exceedingly quick action to take photographs showing virtually no motion. A camera with its shutter open is placed with the light source in a dark room where the action is to take place. A naval shell in flight at 1,842 miles an hour moves only sixty-five-thousandths of an inch during the 2-microsecond exposure when photographed with the newly devised equipment.

NEW FIRING CHAMBER

The world's largest firing chamber, which the Ordnance Department calls a "stratospheric facility" because it can simulate great changes in temperature and air pressure will be used for

CONTINENTAL
Red Seal
ENGINES

BUILT FOR THE JOB!



NOW BIG ENGINES DESIGNED FOR TRANSPORTATION

R-6602:	200 h.p. at 2600 rpm.
R-6572:	190 h.p. at 2600 rpm.
R-6513:	170 h.p. at 2600 rpm.
B-6427:	130 h.p. at 2600 rpm.
B-6371:	100 h.p. at 2600 rpm.
M-6330:	105 h.p. at 2800 rpm.
M-6290:	95 h.p. at 2800 rpm.
M-6271:	90 h.p. at 2800 rpm.
F-6226:	75 h.p. at 3000 rpm.
F-6209:	70 h.p. at 3000 rpm.
F-6186:	60 h.p. at 3000 rpm.
F-4162:	55 h.p. at 3000 rpm.
F-4140:	50 h.p. at 3000 rpm.
F-4124:	45 h.p. at 3000 rpm.
Y-4112:	40 h.p. at 3000 rpm.
Y-4091:	35 h.p. at 3000 rpm.
Y-4069:	25 h.p. at 3000 rpm.

Big, new, high-speed engines delivering up to 250 h.p. have recently been added to the Continental Red Seal line. These new models are of post war design and incorporate many advances in engineering, in materials, and in manufacturing technique. Their improved power characteristics and higher governed speeds make possible faster on-time schedules for trucks and buses. These engines have already proved their efficiency and reliability in millions of miles of use.

Bulletins are available giving further information on any of the engines listed at the left.

Continental Motors Corporation
MUSKEGON, MICHIGAN

AETNA-STANDARD

- Sizing Mills
- Pay-off and Tension Reels
- Continuous Strip and Sheet Galvanizing Lines
- Continuous Strip Long Terne Lines
- Coilers
- Levellers
- Mill Tables
- Piercing Mills
- Plug Mills
- Rolls
- Slitting Lines

SEAMLESS TUBE MILLS

CONTINUOUS BUTT WELD PIPE MILLS

DRAWBENCHES FOR BARS AND TUBES

COATING EQUIPMENT

STRIP FINISHING EQUIPMENT

Aetna-Standard specializes in the designing, engineering, manufacturing, and installing of mill equipment, such as the products listed above. In addition, Aetna-Standard works closely with the Ordnance division in research on new methods and new products.

The AETNA-STANDARD ENGINEERING Co.
YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED
THORNABY-ON-TEES, ENGLAND
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TORONTO, ONTARIO, CANADA

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries

New Developments

firing tests on the fastest aircraft's guns and ammunition under conditions met in combat.

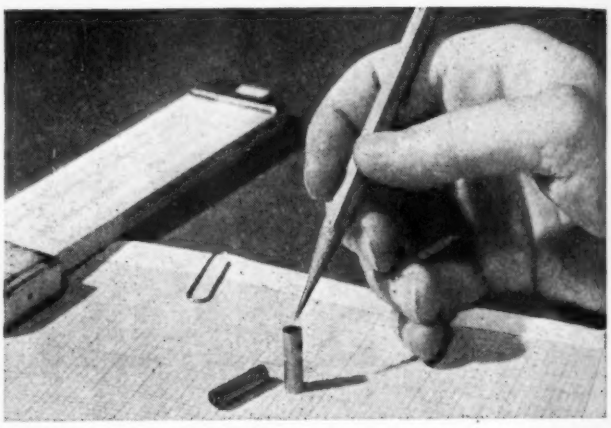
Starting at 70 degrees above zero and at sea-level pressure, weapons as large as the 105-mm. cannon can be fired as temperature and pressure are varied to simulate a plane climbing at 5,000 feet a minute. At 50,000-foot altitude, the temperature has plunged to 70 degrees below zero and the pressure is about 1.7 pounds. Descents can be simulated to speeds approaching that of sound.

NEW ELECTRONIC DEVICES

An amazingly simple device, capable of performing efficiently nearly all the functions of an ordinary vacuum tube and known as the Transistor works on an entirely new physical principle discovered by the Bell Telephone Laboratories in the course of fundamental research into the electrical properties of solids.

The whole apparatus is housed in a tiny cylinder less than an inch long. It will serve as an amplifier or an oscillator: yet it bears almost no resemblance to the vacuum tube now used to do these basic jobs. It has no vacuum, no glass envelope, no grid, no plate, no cathode, and therefore no warm-up delay.

Two hair-thin wires touching a pinhead of a solid semiconductive material soldered to a metal base are the principal parts



This tiny device can do the work of a full-sized vacuum tube.

of the Transistor. These are enclosed in a simple, metal cylinder not much larger than a shoelace tip.

When fully developed, the Transistor is expected to find new applications in electronics where vacuum tubes have not proved suitable. The device consumes less than one-tenth the power of an ordinary flashlight bulb.

A new vacuum tube which radiates as much energy as the biggest American standard broadcasting stations at the extremely high frequency of 1,000,000,000 cycles a second, has recently been developed.

Waves from the new "magnetron" heat up everything near the laboratory transmitter, including human beings, who run a fever when standing near it. The magnetron's 50,000-watt output is the most power ever produced at the billion-cycle frequency. Frequency of the tube's output is roughly 1,000 times as high as that of a standard broadcasting station.

STANDARDIZATION

The Chairman of the Munitions Board has announced the establishment of the Munitions Board Standards Agency and the Munitions Board Cataloguing Agency. The function of the standards agency is to develop standardized equipment for the National Military Establishment. The task of the cataloguing agency is to develop a uniform catalogue of all items used by the Military Establishment in peace and war. (*Continued on p. 84*)

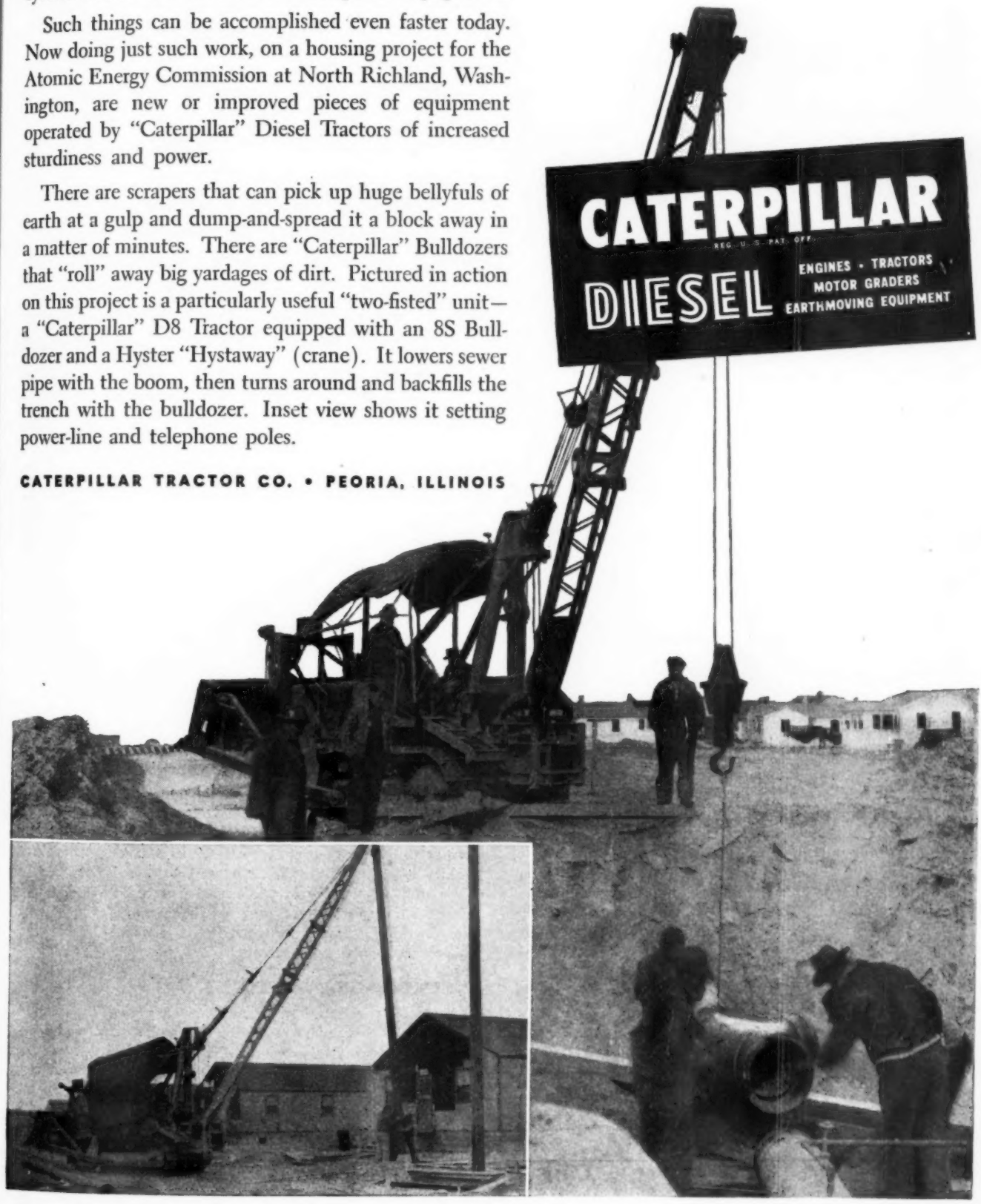
BUSY BUILDER of "what have you"

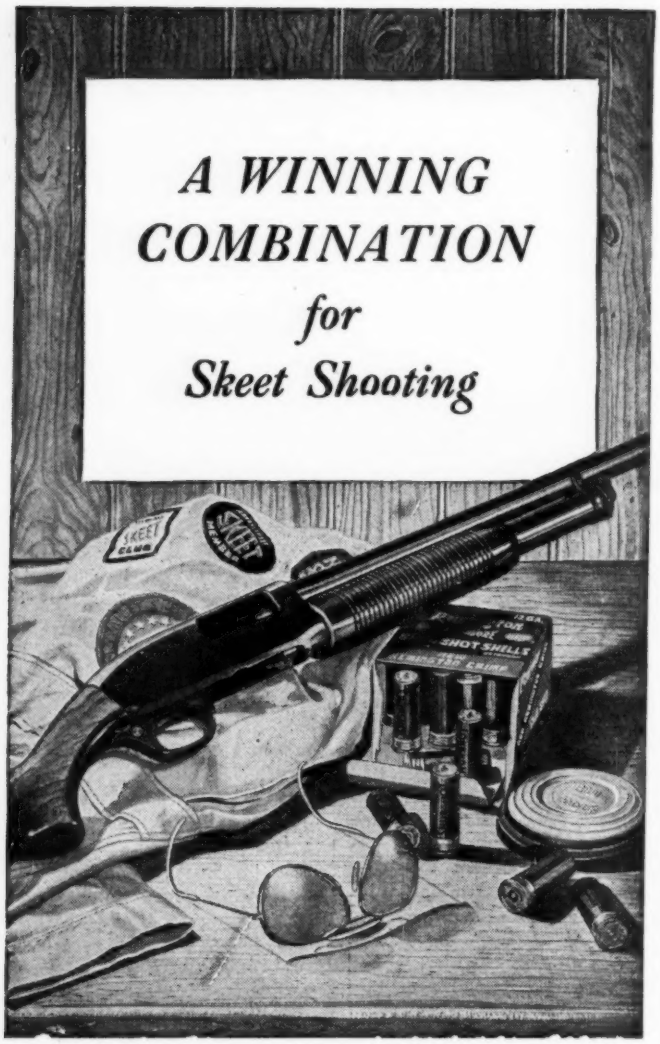
WHO does not remember the speed with which, during the war, cantonment sites were leveled, streets constructed, sewage, light, power and communication systems built with the aid of "Caterpillar" equipment?

Such things can be accomplished even faster today. Now doing just such work, on a housing project for the Atomic Energy Commission at North Richland, Washington, are new or improved pieces of equipment operated by "Caterpillar" Diesel Tractors of increased sturdiness and power.

There are scrapers that can pick up huge bellyfuls of earth at a gulp and dump-and-spread it a block away in a matter of minutes. There are "Caterpillar" Bulldozers that "roll" away big yardages of dirt. Pictured in action on this project is a particularly useful "two-fisted" unit—a "Caterpillar" D8 Tractor equipped with an 8S Bulldozer and a Hyster "Hystaway" (crane). It lowers sewer pipe with the boom, then turns around and backfills the trench with the bulldozer. Inset view shows it setting power-line and telephone poles.

CATERPILLAR TRACTOR CO. • PEORIA, ILLINOIS





Skeet is a great sport—one you can enjoy for years to come. However, your fullest appreciation comes as your skill increases. And that's when you find that the *right* gun and the *right* ammunition count most.

Champion skeet shooters have found a *winning* combination in the Remington Model 31 shotgun and Remington Shur Shot shells with the Remington Flat-Top Crimp. The Model 31 is a pump action repeating shotgun which, during the war, aerial gunnery students nicknamed "the gun with the 'ball-bearing' action" because of its velvety-smooth operation. And Shur Shot shells with Remington Flat-Top Crimp eliminate "blown patterns," which cause unexplainable misses. You get even distribution of shot pellets with no holes or openings for targets to pass through unbroken.

For free literature on this popular combination, write Remington Arms Company, Inc., Bridgeport 2, Conn.

Remington

DU PONT

"If It's Remington—It's Right!"

Shur Shot is a trade mark of Remington Arms Company, Inc.

New Developments

SEA

SUBMARINE LAUNCHES MISSILES

The first effective use under simulated battle conditions of submarines with high underwater speed and of a submarine capable of firing guided missiles while submerged was accomplished by the 1st Task Fleet.

The two high-speed submarines used were the POMIDON and the DIODON, which were converted at the Mare Island Naval Yard. Their actual underwater speed is a secret, but it is believed to be at least sixteen knots.

German-type V-1 and V-2 rockets were launched from the submarine CUSK against ship and shore targets.

NEW NAVAL RESEARCH CHIEF

Rear Adm. Thorvald A. Solberg, an expert on atomic energy, was nominated by President Truman recently to be the Navy's new Chief of Research. Admiral Solberg, named to serve a 3-year term, will succeed Adm. Paul F. Lee, of Berkeley, Calif., who retired in July.

The new research chief directed preparation of the ships used as targets for the atomic bomb test at Bikini. Afterward he headed their inspection to determine effects of the bombs.

STARS TO GUIDE MISSILES

"For the moment, at least, only automatic celestial navigation can provide the accuracy and reliability which is demanded in a long-range guided missile." This is the opinion of Charles A. McPheeters, director of Self-Navigation for the Navy Bureau of Aëronautics and head of the guidance laboratory control section of the Bureau's air-missile test center.

Automatic celestial navigation is the system of directing robot projectiles by incorporating in them machinery which, like human navigators on ships, will take constant bearings on stars or other heavenly bodies. In addition to its great accuracy, this method is regarded as practically the only way to avoid enemy disruption of direction signals.

In one system of celestial guidance—the "automatic star seeker"—the missile mechanically seeks out a selected heavenly body and tracks it throughout the main part of its flight. The second main system uses mechanical computations based on two or more stars, as in marine navigation.

CAMOUFLAGED WAKES

The Navy has found a way to eliminate the tell-tale wakes left by vessels steaming at night, thus permitting great security from "snooper" planes and enemy observers.

It was found that because of oxidation, millions of minute organisms living in the sea gave off a phosphorescent light when disturbed by a ship's propellers. It was also found that the war-developed dye to frighten away sharks would cover the glow, making it invisible from the air as well as from the surface.

By utilizing the dye to mix into a man-made fog that was spread as the using vessel moved over the sea, any phosphorescent glow marking its passage was completely eliminated, making the ship secure from visual observation.

PHANTOM SEA BOTTOM

American scientists have stumbled upon a vast layer of life in the oceans that some day may become an important new addition to the world's food supply.

It is a layer of water 1,000 to 2,500 feet down and averaging perhaps 500 feet thick. It swarms with unidentified living things. These creatures reflect sound waves and thus register on echo sounders used to determine ocean depths.

The Navy calls this layer "the phantom of the sea" because it

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Switch to N-A-X HIGH-TENSILE. Utilize its greater strength and corrosion resistance by designing lighter sections. Boost production per ton as much as 33%. Get a stronger, longer-lasting finished product.

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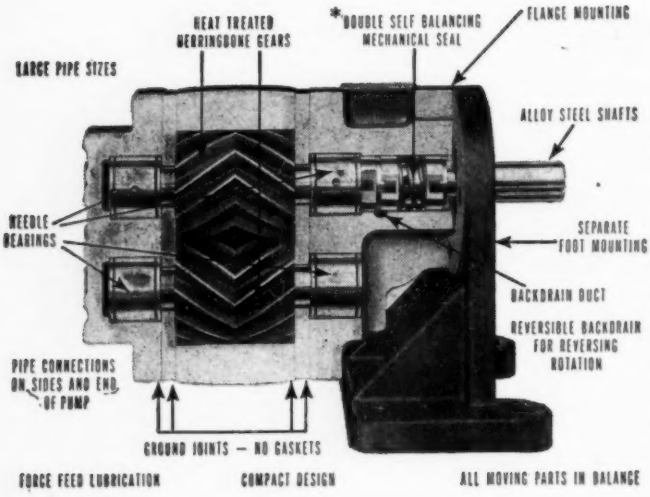

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However, evidence that the layer is composed of living things points to the existence of a source of protein in a space almost as large as the combined areas of the oceans, which cover three-quarters of the earth's surface. Such a tremendous cache of potential food, efficiently utilized, could mean the difference between scarcity and plenty for all humanity.

AIR

ARCTIC AIR AIDS

A chain of long-range navigation stations stretching across the Arctic frontier of Alaska and Canada is nearing completion. The stations will be of inestimable value to air navigators flying to the North Pole and across any part of the polar ice packs, permitting the navigators to fix the position of plane exactly when no other means of navigation is available.

"Some progress" also has been reported by the Air Command on an air-raid warning system designed to detect enemy planes approaching the Arctic frontier of North America from any part of Europe or Asia.

NEW GLIDER DESIGN

A new all-metal glider which the Army Field Forces plan to use for carrying troops or cargo has proved both stable and maneuverable in flight tests. The "Avitruc" is the first all-metal glider built in the United States and is probably the largest in the world. Its official designation is the CG-18A.

In the fuselage there is room for thirty-two soldiers with complete combat equipment or space for four tons of cargo. A cargo ramp in the rear permits easy loading of a 1½-ton truck.

ROCKETS FOR THUNDERJETS

Offensive power of the U. S. Air Force's Republic F-84 Thunderjets has been increased considerably by the addition of high-velocity aircraft rockets to the normal operational equipment of six caliber .50 machine guns. The 7-ton Thunderjet now carries eight 140-pound rockets, four under each wing. They are mounted in pairs and fired individually by the pilot.

LONGER RANGE JET ENGINE

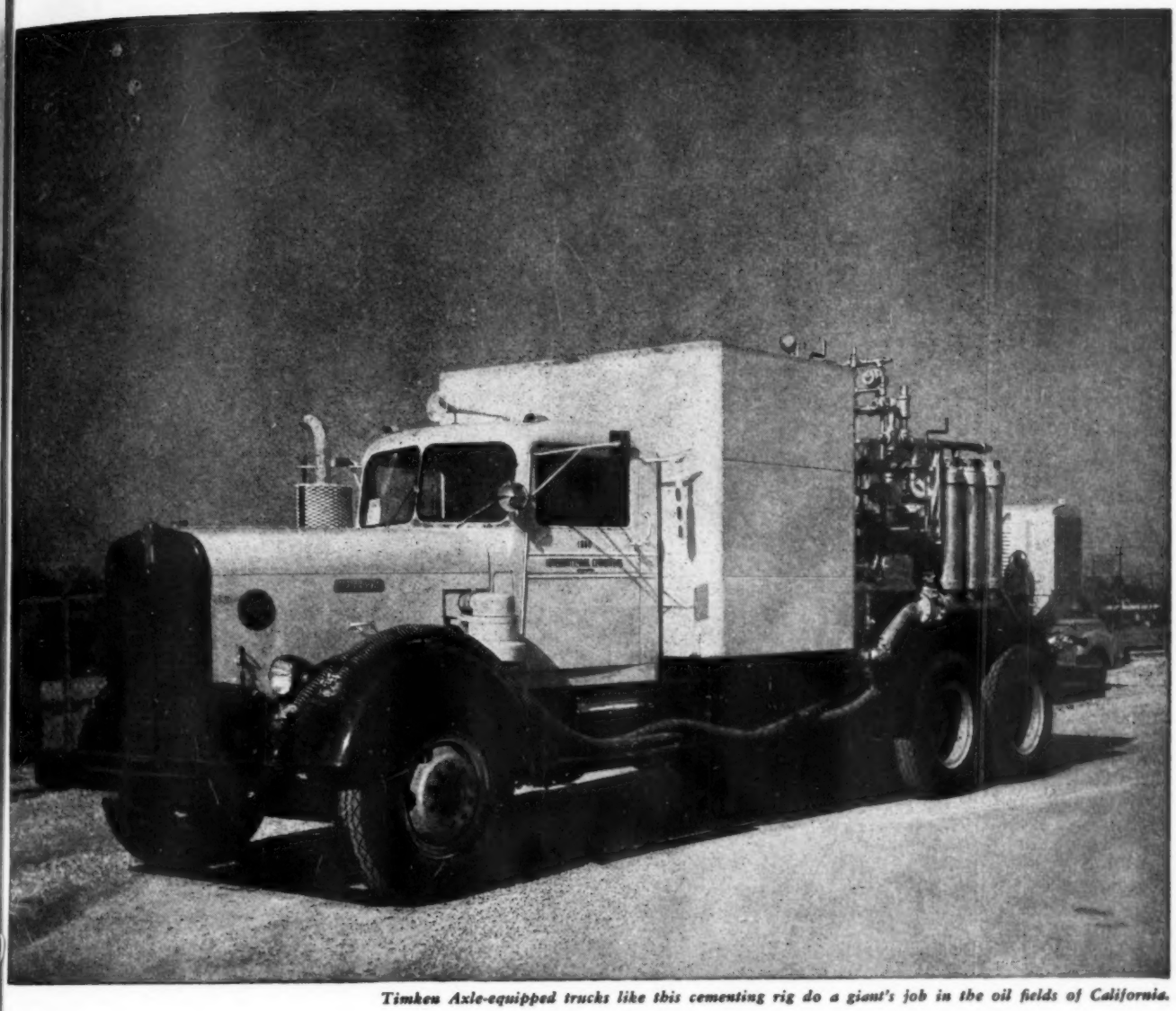
Development of an 8,000-horsepower long-range jet engine for future combat planes of the Air Force has been announced by the Lockheed and Wright Aëronautical Corporations. The announcement said the new engine will permit tacticians to deploy forces "on the same radius of operations used today with the most advanced nonjet fighters and bombers."

DETACHABLE-FUSELAGE TRANSPORT

A detachable-fuselage aircraft to be known as the XC-120 pack plane, is now under order from the Fairchild Corporation for the U. S. Air Force. Designed on the trailer-truck principle, the pack plane will closely resemble the Fairchild Packet C-119 in configuration. It will be capable of flying with or without its fuselage. Preliminary designs call for a pack with a pay-load capacity of 9 tons at a range of 2,000 miles. As a medical unit, the pack will accommodate thirty-six litter patients.

222-PASSENGER TRANSPORT

The Air Force has placed an order with the Douglas Aircraft Company for 28 C-124's—giant transport planes 2½ times as big as the well-known C-54 "Skymaster." The new transport will have a passenger capacity of 222 troops. Although the huge plane has a design gross weight of 175,000 pounds, it will utilize the same airport facilities currently handling C-54's.



Timken Axle-equipped trucks like this cementing rig do a giant's job in the oil fields of California.

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Every year brings an increased demand for larger, more powerful motor trucks to handle specialized hauling in America's heavy industries.

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All the design and production know-how that goes into these huge, heavy-duty civilian vehicles is at the service of the Army—to assure the world's finest military transport whenever it is needed, in whatever quantity, for whatever purpose.

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Attack by Air

Airheads Will Replace Beachheads in Future Conflicts

MAJ. GEN. JAMES M. GAVIN is not the first general to come up through the ranks. But he is the first general in American history to make four combat parachute jumps with his men—Sicily, Salerno, Normandy, and Holland.

He was the first allied leader in World War II to crack the "soft underbelly" of Fortress Europa when he and his 82nd Airborne troopers hit the silk over Sicily in September 1943.

Just eight hours after receiving Gen. Mark Clark's dramatic call for help, General Jim and his boys had enplaned from Sicilian bases and were spilling out into the warm Italian night air over the threatened Salerno beachhead.

In the Normandy invasion, General Jim and his 82nd "devils in baggy pants" made a third spectacular jump and had liberated the first French town, St.-Mère Église, some eight hours before the beachhead boys hit the coast.

General Gavin and his fighting paratroopers first stopped Von Rundstedt in the crucial Battle of the Bulge, just outside of Liége, Belgium.

But General Gavin says that his six campaigns, seven river crossings, and four combat jumps in the European Theater are past history, very old hat, and are valuable only for the experience gained the hard way in planning America's new atomic-age airborne Army.

Control of the air is essential, General Gavin believes. Control of the air in any future conflict will make it possible to transport airborne troops to any spot on the globe. "In any future hostilities," he says, "airheads will assume the importance of beachheads."

Land fighting in the atomic age will not be a repetition of Anzio—heroic men fighting with their backs to the sea. In tomorrow's combat there will simply be a relatively small number of paratroops and airborne troops right in the middle of a whole lot of enemy territory. To American fighting men, at least, this will be a familiar pattern. It will recall frontier days when our pioneer forefathers fought for their lives from behind covered wagons against encircling Indians.

General Gavin is convinced that atomic weapons and guided missiles will demand dispersion in all military operations of the future. Dispersion, however, will give only limited protection to our armed forces, our industries, our cities, our airfields. No area will be completely immune from airborne or guided-missile attack. The only possible foolproof protection will be to deny the potential enemy the use of the air base or missile sites he would have to possess in order to inflict on us a mortal blow.

ONLY an aggressive spirit will save us. Our air, sea, and airborne combat troops must seek out the enemy and destroy him. This type of warfare will demand speed and mobility. It will demand new types of fast transport planes. It will demand lighter weapons with greater firepower. In short, most of our combat equipment, from helmets to howitzers, must be modernized so as to fit into the airborne pattern of the future supersonic air age.

The foot soldier of the future will do most of his hiking in a pressurized cabin at an altitude of some 30,000 feet and at a speed of 700 miles an hour. His destination may be Africa or Eurasia. He will drop to earth there in a detachable fuselage and will be resupplied in a matter of hours with food and medicines from Chicago or Duluth, tanks and other armored vehicles from Detroit, small arms and ammunition from Philadelphia.

Startling technological innovations that will revolutionize the science of warfare are just over the horizon. We welcome these life-saving military developments. But let us never forget that wars are not won by push buttons or automatons but by combat troops.

By all means give us the new atomic gadgets. But give us also the American breed of fighting men. Give us outfits like the 82nd Airborne Division. Give us leaders like Gavin!

Maj. Gen. James Maurice Gavin, whose photograph appears on the front cover, began his notable Army career as a private in a Coast Artillery regiment in 1925.

He is a graduate of West Point, the Infantry School, the Parachute School, and the Command and General Staff School.

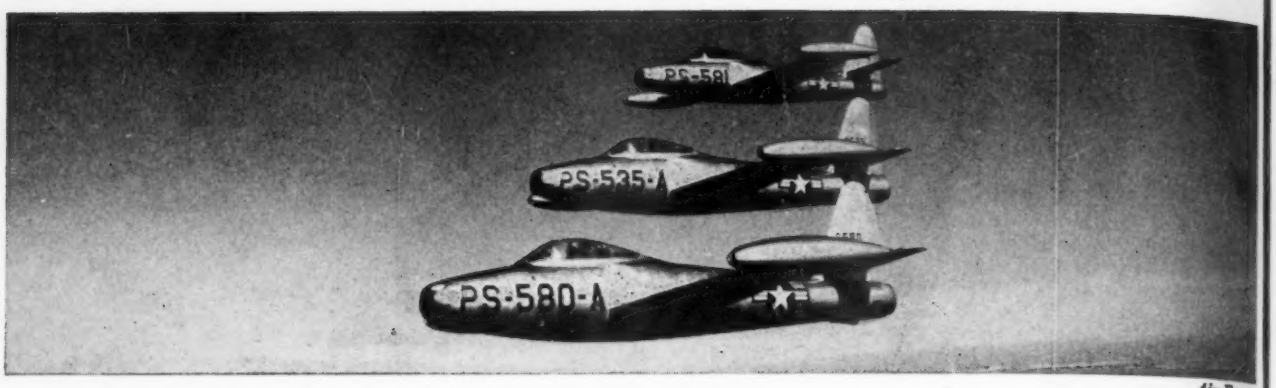
After various tours of duty in the Philippines and the United States, he became Commanding Officer of the 505th Parachute Infantry in 1942 and remained in command when the regiment was assigned to the 82nd Airborne Division in 1943.

Colonel Gavin's regiment spearheaded the assault of Sicily. He commanded the regiment in the parachute landing at Salerno Bay and was made assistant division commander of the 82nd Airborne Division while on duty in Naples.

In the Normandy invasion Colonel Gavin commanded the parachute assault echelon of the 82nd Airborne. Later in 1944 he assumed command of the division and led it in the airborne operation near Nijmegen, Holland, in the fall of 1944, the Battle of the Bulge the following winter, and the spring offensive of 1945, until the surrender of the German Army.

General Gavin, a 41-year-old New Yorker, holds twenty-three American and foreign decorations. In March 1948 he became Chief of Staff of the Fifth Army. In June 1948 he was one of the principal speakers at the Thirtieth National Meeting of the American Ordnance Association. His address is published on page 106 of this issue.—THE EDITORS.

FLYING INFANTRYMEN of the new Army's airborne divisions will spearhead the attack in future combat (Signal Corps photo).



Air Forces

Why Preparedness?

by

James L. Walsh

President,
American Ordnance Association

IT used to be said that war was a grim choice between "kill or be killed." After some thirty years of thinking this thing out, we in the American Ordnance Association have come to the conclusion that we should amend this and say now and in the future that "war is a choice between *being ready, willing, and able to kill*—or be killed."

In support of this theory we offer this irrefutable evidence. During the first World War, poison gas was used by both sides. The Germans had some idea of using it during World War II. Certainly they were not deterred from using gas on allied forces by any humanitarian considerations. We let it be known very quietly that for every pound they used against the allies, we would use a ton against them. They'd start it—we'd finish it. The Krauts were not so dumb—they got the point. Result: we won the gas war—without firing a single gas shell or dropping a single gas bomb.

The Japanese were intrigued with the possibilities of bacteriological warfare. They floated hundreds of balloons from Japan to Alaska, Canada, and our Northwest, planning eventually to send over bacteria to spoil our crops, kill our trees, poison our edible animals, and start new and fatal epidemics to decimate the people of America.

Again, we let the enemy know that if they started bacteriological warfare we were in a position to do a lot more harm to them than they could ever hope to do to us. The Japs were not so dumb either. They also got the point. Result: we won the bacteriological war—without releasing a single microbe.

Germans Got the Point

Gen. George S. Patton's gallant Third Army averaged a total of only 250,000 men. Yet they took 1,300,000 prisoners. How? By demonstrating that they were immediately ready, unhesitatingly willing, and very completely capable of killing their opponents. Again, the Krauts got the point. Result: they preferred to stay alive—so they surrendered in droves. Here, *obvious* logistical superiority in firepower and mobility operated to save the lives not only of our own troops but also of enemy combatants.

This keynote address was delivered by Colonel Walsh in opening the Thirtieth National Meeting of the American Ordnance Association at the Book-Cadillac Hotel, Detroit, Mich., June 9, 1948.

As a matter of fact, there never was an occasion, either in the Pacific or in Europe, when the United States forces were not pitted against numerically superior enemies. Then how did we win? We won because our troops had better tools and more of them—in brief, ordnance superiority. And, as General Eisenhower told us in Detroit two years ago, we were able to use technology and machines to save human lives. Japanese, German, and Italian troops opposed to us lost a total of 1,592,000 killed. United States forces lost a total of 313,000 killed.

And that is exactly 313,000 too damned many!

True, superior weapons cut down our battle-death expectancy by eighty per cent. True also, a proper degree of scientific and industrial preparedness might well have cut down our battle deaths to zero—by averting war altogether.

Working for Peace

We in the American Ordnance Association are working for peace—not merely passing pious resolutions and indulging in wishful thinking—but working hard to keep our country strong for peace. We have asked our good friends of the Canadian Ordnance Association to meet with us occasionally, to consider our philosophy, to discuss our methods, and perhaps to join us in our endeavors. If they see the situation in the same light as we do, then at least this continent will be safe. And, if we can get a few other peace-loving nations to join us along that same line of thought, perhaps the world will be safe.

Peace is the high goal of our endeavor. Peace is the answer to "Why Preparedness?"

Simplify for Production

Ordnance Production Methods Must Be Less Complicated for Wartime Output

by

Maj. Gen. E. S. Hughes

"Until we solve the broader phases of our problems, there is such a thing as getting too scientifically detailed for our own good"

I AM delighted, as Chief of Ordnance of the Army, to find that there is a shift in manufacturing problems from the East Coast to the Middle West.

For many years we have held Ordnance Day at the Aberdeen Proving Ground, Md., in complete violation of the strategic plan of the United States, which is to have nothing closer than 200 miles to the eastern seaboard or the western seaboard!

We are gradually moving the interest in mass production westward, and I hope that before long we will have a meeting of this kind still farther west.

Everybody in the United States is involved in this particular problem, and this is the first indication that I have seen, as far as these meetings are concerned, that the strategic plan has grown to maturity.

As technicians we have our limitations. We have recognized that fact in the program we set up some time ago, a program in which Mr. Knowles has shown the greatest interest. In this program we acknowledge that the men in mass production are civilians. They are not Army officers, and they are not Navy officers.

Dependence on Civilians

In the Ordnance Department we get, as best we can, the military characteristics of a required item. These we translate, again as best we can, into drawings and specifications. From that point on—since we do not know all there is to be known about mass production—we have to lean heavily on the civilian mass-production experts.

Recently I attended a meeting of the American Ordnance Association's Ammunition Committee in which many details in the manufacture of bombs and rockets and other forms of explosives were discussed and many detailed problems handed out to the engineers and representatives of the firms present there.

I made a comment then which I want to repeat now, and that is: Let us not get too immersed in the details of a gun or a piece of ammunition. Until we solve the broader phases of our problem there is such a thing as getting too scientifically detailed for our own good.

What we have to think about is the production end of this particular problem. The war that we visualize is a war in which, as we see it, the production capacity of the United States is going to decrease rather than increase. I want to emphasize that fact so you will all remember it.

Therefore, we will have to simplify our processes of manufacture, and instead of taking, as was done yesterday, some particular component of a round of ammunition and examining it from the standpoint of how to produce that particular thing, I am asking you people today to examine our whole aim to see whether or not, from an engineering point of view, we can simplify some of the items of equipment which we are making.

The A.O.A. Committees

Returning to Mr. Knowles, may I say that he has been extremely helpful. He has worked hard, and his commodity committees of the A.O.A. are, to my mind, the answer to everything that involves the Ordnance Department from a mass-production point of view. Those committees are interested; they are talented; they have given freely of their time; they will continue to give freely of their time. From them we are gaining many items of information, and we are gaining help which we would not have gotten any other way.

General Hughes, Chief of Ordnance, U. S. Army, delivered these remarks during the Ordnance Technology Round Table at the Thirtieth Annual Meeting of the A.O.A. held at the Book-Cadillac Hotel, Detroit, Mich., on June 9, 1948.

Weapons and the Navy

The Bureau of Ordnance Plans New Equipment To Keep America Strong

by

Rear Adm. A. G. Noble

"Continuing emphasis and effort is being made for the satisfactory and early solutions of the problems involved"

WITH the Unification Act which created the National Military Establishment and from which has evolved the expression of the functions of the armed forces, the Navy's field of interest and responsibility has been more clearly defined.

This field of responsibility follows closely that which had previously been assumed by the Navy, and the research and development program of the Navy Bureau of Ordnance has been conceived for the fulfillment of its part of that responsibility.

The Navy's position in the National Military Establishment may briefly be described by the statement of its primary functions, which are:

(1) To organize, train, and equip Navy and Marine forces for the conduct of prompt and sustained combat operations at sea, including operations of sea-based aircraft and their land-based naval air components;

(2) To conduct air operations as necessary for the accomplishment of objectives in a naval campaign;

(3) To organize and equip, in coordination with the other services, and to provide naval forces, including naval close air support forces, for the conduct of joint amphibious operations and to be responsible for the amphibious training of all forces as assigned for joint amphibious operations in accordance with the policies and doctrines of the Joint Chiefs of Staff.

The foregoing does not include all the primary functions assigned to the Navy but is sufficient to establish the nature and extent of my Bureau's programs. In simpler language, the Navy's task may be stated to be: To destroy enemy naval forces and sea commerce, to maintain effective control of the sea, and to project our might overseas.

"Seek Out and Destroy"

In connection with these tasks, in event of hostilities the Navy will seek out and destroy the enemy's naval forces wherever they may be and will sink or drive from the surface of the seas his sea-borne commerce. This is to ensure that there will be no serious opposition to our use of the seas and, further, it is to deny to the enemy access to the markets of the world.

Our long-standing policy of carrying the fight to the enemy rather than to engage in combat within and over our own territorial limits necessitates the projection of our armed might overseas. This determination on our part can only be made possible through the successful execution of our tasks of destroying enemy naval forces and maintaining control of the seas.

The responsibility of the Bureau of Ordnance to make possible the Navy's execution of its primary functions may be briefly stated: It is charged with the design, procurement or manufacture, storage, issue, and maintenance of efficient armor, armament, and ammunition for the Navy, including its ships and aircraft.

In the discharge of this responsibility, the Bureau has set up three principal programs in the fields of research and development. These are aviation ordnance, antiaircraft defense, and antisubmarine warfare.

The program under aviation ordnance is intended to furnish our naval aircraft with the most efficient types of guns, rockets, aircraft bombs, torpedoes, and mines—all to be controlled in their use by efficient aircraft sighting and fire-control systems.

The Bureau of Ordnance strives to conceive, design, and deliver materials in these categories which are not exceeded by those of any other nation.

Rear Adm. Albert G. Noble, Chief of the Navy's Bureau of Ordnance, delivered this address at the Ordnance Technology Round Table during the first session of the Thirtieth Annual Meeting of the A.O.A. held at the Book-Cadillac Hotel, Detroit, Mich., June 9, 1948.

In the execution of our policy to carry the fight to the enemy, there is a requirement that we project our forces into the proximity of territories held by the enemy. Since this may require movement overseas it will probably subject our naval forces to attack from enemy aircraft and air missiles.

It therefore becomes necessary to arm our ships with adequate means which, when used in conjunction with our own combat aircraft, will enable them to carry out their mission and not be driven off.

Antisubmarine Warfare

Again, in the projection of our strength overseas it is probable that our ships will be subject to attack by enemy submarines. The antisubmarine warfare program for the defense of our ships comprises the development of underwater missiles, such as depth bombs, torpedoes, and underwater projectiles, together with the necessary fire control for their effective use.

As a matter of continuing responsibility there is the necessity for maintaining our developments of ordnance of all types abreast of the technological developments of other nations. This task at the present time is principally associated with the solution of the problem of high-speed targets, both under the sea and in the air. I believe that reasonable progress has been made, is now being made, and will continue to be made in the future.

Ordnance Electronics

New Concepts in the Art of Fire Control

by

Donald A. Quarles

"We must expect the current of technical ideas to flow in the other direction —that is, from the civilian into the military arts"

TRADITIONALLY wars are fought, at least at the start, with the weapons and equipment that were tried and proved in the previous war. Wars are won with equipment devised in wartime and introduced under stress of wartime conditions.

While these two statements are only partial truths, each makes an important point. The first brings out the practical difficulties that have always been encountered in developing and introducing improved military equipment in time of peace and the second emphasizes the importance of new technology and new equipment and methods in winning wars.

Let us apply these thoughts to what I might characterize as "ordnance electronics," which is almost synonymous with fire control if "fire" is construed broadly enough to include bombs, rockets, and other missiles as well as more conventional projectiles, and "control" to include robot features built into the missile as well as more conventional directors.

What of Fire Control?

Regarding fire control, where would we be if we were required to fight the next war with the weapons and equipment that were tried and proved in the last? Certainly, we would not be without much effective gear—effective at least until outmoded by the opposing equipment.

Let us take the antiaircraft artillery fire-control system as an example. The primary functions of such a system are: (1) to detect aircraft long enough in advance to permit defense measures to be taken; (2) to identify targets as friend or foe; (3) to track and report target position in 3-dimensional space; (4) to predict future position on the assumption, for example, that the target will continue in straight-line unaccelerated flight; and (5) taking account of the ballistic properties of the gun and its ammunition, the wind, and many other variables, to compute and deliver gun orders—including fuze settings where time-fuzed ammunition is used—best calculated to explode the shell within lethal range of the target.

Even with the target heights, speeds, and visibilities of World War II, optical methods were so limited in usefulness that radar became the main reliance for performing the detection and tracking functions of this system.

Long-Range Radar

We might say that the British took the first step toward a radar fire-control system when they organized long-range radar for early detection of the German air attacks and shorter-range tracking radars for vectoring their night fighters into intercept positions.

Fortunately for their success at that time, it was only necessary to bring the defending planes into the general neighborhood of the attacking bombers, as the interceptors were equipped with airborne radar as well as human eyes and intelligence to complete their mission.

It was a far cry from this crude beginning to the precision tracking and computing fire control system.

Suffice it to say that American genius later evolved and produced in quantity radar fire-control equipment which met World War II requirements admirably. We must recognize that the effectiveness of this gear was related to the characteristics of the targets presented and that it would be very much less effective against the probable targets of the next war. We must also admit that the equipment was bulkier than desirable.

For example, optical tracking, which is advantageous under favorable conditions, was provided as an appendage, and even the tracking radar and the

"Donald A. Quarles, vice-president and director of apparatus development of Bell Telephone Laboratories, has been associated with the Bell System since 1919. He is vice-chairman of the Committee on Electronics of the Research and Development Board of the Federal Government and is a member of the board of directors of the American Institute of Electrical Engineers.

"During World War I he enlisted in the United States Army and served overseas two years before he was discharged with the rank of captain in the Field Artillery.

"In 1919 he joined the engineering department of the Western Electric Company, which in 1925 became Bell Telephone Laboratories. From 1919 to 1924 he was in transmission engineering and research; then for four years he was a member of the inspection engineering department in charge of apparatus inspection engineering.

"He was made director of outside plant development in 1929 and was in charge of the study of telephone materials.

"As director of transmission development from 1940 to 1944 he was in charge of the development of carrier telephone systems, broad-band telephone and television systems, and improved voice frequency transmission systems. During the war the efforts of this department were largely concentrated on military electronic systems, particularly radar, and Mr. Quarles gave his entire time to this work."—HARVEY C. KNOWLES, *vice-president in charge of National Divisions, American Ordnance Association, introducing Mr. Quarles who addressed the Ordnance Technology Round Table during the Thirtieth National Meeting of the American Ordnance Association at the Book-Cadillac Hotel, Detroit, Mich., June 9, 1948.*

computer were separate and not entirely complementary equipments rather than a completely integrated system. Moreover, even under World War II conditions, the facilities for supplying and organizing the tactical information needed by battalion and battery commanders obviously left much to be desired.

In the later phases of the conflict another electronic device, also developed from scratch in the war period, joined this fire-control team; namely, the VT, or proximity, fuze.

Stopped V-1 Blitz

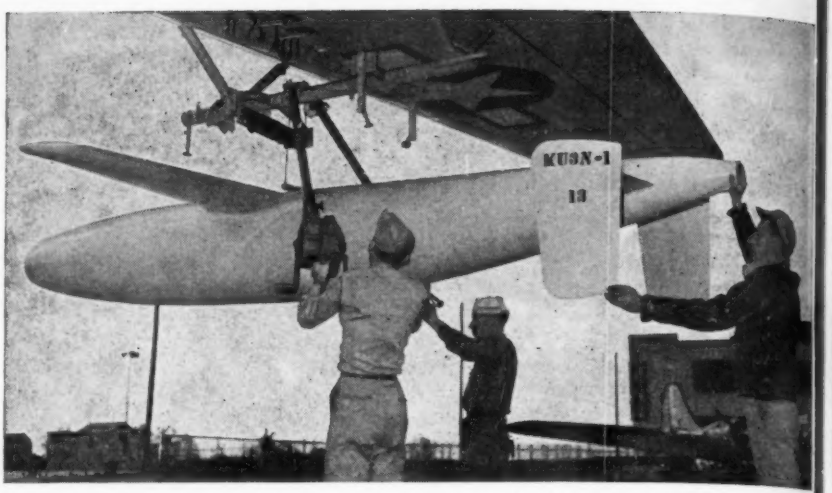
That the team was top notch was most convincingly demonstrated in the V-1 blitz where the combination of radar tracking, electronic computing, and VT fuzing—with the help of some other neat gadgets, such as guns and ammunition—succeeded, notably at Antwerp, in knocking down ninety-three per cent (ninety-nine per cent on the best days) of the buzz-bombs that came over. This was done with an expenditure of only fifty rounds of ammunition per buzz-bomb destroyed, and of these fifty something like half should not count because they were in air when the target ceased to exist.

I am told that the corresponding World War I performance was one aircraft destroyed for each 19,000 rounds expended. Those of us who were artillerymen in that war may wonder how even this figure was reached!

Similar arts were applied with similar successes in naval antivessel and antiaircraft fire. Here the computers commonly employed were mechanical rather than electronic, and VT fuzes were needed and used only for the antiaircraft part of the job, but even so, the electronic contribution was very great.

For example, in the night engagement in Kula Gulf, perhaps nine or more Japanese cruisers and destroyers were wiped out, and in a marvelous display of U. S. naval superiority in the second battle of the Philippine Sea a large chunk of the Japanese fleet was sent to the bottom by radar-controlled fire at night.

There are similar stories about ships that knocked down attacking planes as fast as they came over (thirty-two in as many minutes was one score), about submarines that detected and sank their prey without the opportunity or need to use optical instruments.



Only through the use of electronic developments is this Navy KU3N-1 rocket-propelled guided missile able to seek out and hit an enemy target by remote control.

Variations in the same arts were applied in radar bombing both in high-altitude strategic bombardment of land objectives and in low-altitude attacks on vessels at sea.

Viewed as a fire-control system, the function of tracking in this case becomes that of defining the relative position of the bomber and its target as a function of time and in 3-dimensional space. The computer must predict the future relative position and velocity of the plane and target, and, with due account of bomb ballistics, deliver steering orders to the plane and a trigger pulse to the bomb-release mechanism, all as best calculated to drop the bomb on the target.

Bombing by Radar

In spite of the fact that airborne radar vision of the terrain left much to be desired, the ability to work at night or through clouds and overcast gave the radar bombsight such an important advantage over its very fine optical counterpart that many operations of great strategic importance relied entirely on the electronic method.

Such examples could be multiplied many times. Let us pick only one other that casts a shadow into the future—the Navy's radar-homing glider missile, the Bat, which, after release from its mother plane, could and did seek out and track down an enemy vessel with only such intelligence and direction as its radar and other electronic gear could provide.

Quite obviously we ended the war on a high plateau of electronic achievement. In relation to the enemy's equipment, our gear was highly effective.

However, it is also obvious that this is a relative matter, and as we face the realities of any future conflict we see clearly the serious shortcomings of this same gear and the urgent need for basic improvements. This is a technological race, and it involves the arts of peace as well as of war.

Since its Declaration of Independence, our Nation has been at war about eleven per cent of the time. This reckons the wars up to each armistice that ended hostilities rather than any of the various later dates that one might choose to select. The average is about eight years of peace to one year of war.

Human beings are bound to give primary regard to the eight peaceful years, particularly as they are filled with hope that the ninth year will never come. It is not surprising, then, that with hostilities ended the electronics industry turned its primary attention to peaceful ends. It is, in fact, primarily to such pursuits that we must look for that broadening and deepening of the technology that will be needed to maintain technical superiority in another war.

The tremendous wartime activity in electronics certainly left its mark on postwar technology, but we must expect the main current of technical ideas to flow in the other direction—that is, from the civilian into the military arts.

Here, I could perhaps do best by speaking broadly of the postwar trends in the field of public-service telephony with which I am most familiar. Several very important technological trends are apparent here: the trend toward higher frequencies and the trend toward greater mechanization, to mention only two.

Important Advances

Paralleling these and closely related to them there have been important advances in materials, component designs,

and circuit techniques resulting in such things as miniaturized apparatus and neater circuits and designs, all tending to increase the power and usefulness of electronic methods.

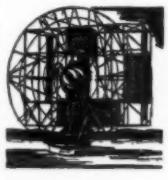
As to higher frequencies, I think we must admit that the application of centimeter waves to radar during the war greatly stimulated technology in this field. It is, however, a fact that the foundations for centimeter or microwave transmission had been laid before the war. In any event, application of these superhigh frequencies to such purposes as the radio relaying of large blocks of communications circuits is a very important feature of our present-day work.

I might mention in passing that such radio relays employ narrow beams that in some respects have more similarity to open-wire telephony where the waves are guided to their destination by pole lines than to the more familiar long-wave broadcast radio.

Up to very recently the radio art was limited by our ability to generate and handle the progressively higher frequencies. With success in pushing up the practicable frequency limit, we are now bumping our heads against one of nature's ceilings; namely, the absorption of millimeter waves in the atmosphere, their dispersion by rain droplets, and the like.

Speaking of open-space radio as distinguished from waveguide transmission, it would appear that the whole usable radio-frequency spectrum has already been opened up for what we may now expect to be rapid exploitation.

Of similar nature is the trend toward mechanization. Dial telephony is, of course, not new. Many of the features of the postwar systems that are too intricate for discussion here are, however, new. Moreover, the extension of mechanization to long-distance switching is very modern and simply indicative of the demand for vast amounts of long-distance communication and at a greatly accelerated pace.



The mechanism which is called into play by the twist of the telephone dial is perhaps the most complicated and most nearly intelligent robot that human beings have created. Even to mention the functions it performs without human assistance would be beyond my present scope. It is significant for our present purpose, however, that gear of this kind can be made to perform such operations reliably and for a long service life. It is significant because the tempo of the next war will force us to apply such mechanization to some of the military situations which we can foresee.

Electronic Switching

Switching essentially is the process of establishing contact between two or more conductors. Originally, it was an operator's hand that brought the two together. Next, it was electronically driven switches which had gross motions reminiscent of the operator's hand motions.

In a modern exchange, however, one would have to look closely to see anything move. Most of the motions are the opening and closing of relay contacts, with distances measured in thousandths of an inch and time measured in thousandths of a second.

For some operations, even such speeds are too slow, and more and more one finds mechanical motions replaced by the motions of electrons in a vacuum tube. This simply means that more and more powerful tools are being developed for creating such mechanisms and making them more versatile.

Fortunately we have in the cognizant offices of the military services leadership that is thoroughly informed on the merits and shortcomings of World War II electronic equipment, particularly when the characteristics of this equipment are stacked up against the requirements of the future.

Even before the war ended they were well aware, for example, that fire-control equipment that was highly effective against relatively low speed bombers and buzz-bombs flying straight and level might be completely ineffective against supersonic missiles or even high-altitude, high-speed maneuverable planes.

Our military leaders saw not only that the situation called for maximum refinement of the equipment we had but for a whole new look at the over-all problem—a realistic, quantitative evaluation of time factors, sources of error, and probabilities of effective action. Such analyses have been made. From them it is clear that solution will tax our technical resources.

Not only must all components be integrated into a well-planned whole, with none contributing more than its proper share of the error, but time factors are such that tactical commanders must be given the maximum of mechanical aid to enable them to comprehend the situation quickly and to require of them only that they inject essential judgment and decision into what would otherwise be completely automatic action.

Such a system will call for the most up-to-date methods of electrical transmission not only of large amounts of visual and aural information but also of position data and servo orders. It will also require all the tricks of the electronic switching, computing, and mechanization arts to provide means for displaying, sorting, organizing, and predicting complex information, and, finally, of executing actions based thereon in time to be effective against enemy attack.

Guided Missiles

Another variety of ordnance electronics that is uppermost in every one's mind is missile guidance. I have mentioned earlier that the Navy's radar-homing Bat achieved some success in the last war; there were a few other significant cases of successful missile guidance.

With all that has been done then and since, guidance still poses many big problems for electronics to solve. Analysis indicates that at every turn we are called on to do things that are a little bit tougher than the World War II electronics art could handle. The elements of the problem are closely akin to the radar fire-control problem, however, and, given time and the application of scientific methods, I think we can safely expect that they will be solved—in fact, that others as well as we will solve them. Just what distances can be negotiated and what effectiveness can be achieved still remain to be seen.

In conclusion, I think I may safely say that we in the electronics field recognize the tremendous rôle that our art must play in any future world conflict.

We recognize that this is not just a race against time—it is a race against a competitor. This is the kind of challenge that American industry met in the last war, and I know it is the kind of challenge that the members of the American Ordnance Association propose to meet from here out.

The Guided Missile

Development of the V-2 Rocket Began a New Era of Ordnance

by

Dr. C. F. Green

"Missile development at the end of World War II was equivalent to that of the airplane at the close of World War I"

AS Americans, it is with a feeling of humility that we approach the subject of guided missiles, because it was the Germans who exploited this field so extensively before and during World War II.

It is with all the more humility that we recall that the Germans used the works of our Dr. R. H. Goddard for reference in their early development. Dr. Goddard, father of American rocketry, had done fundamental development before the end of World War I, but in the intervening years lacked the encouragement to expand that work adequately.

Serious rocket development was started in Germany in the years 1929-1930 by a few groups of private inventors. Attention of the Army Weapons Group was drawn to this work in 1933, and during this year the first of the "A" weapons—the A-1, a 330-pound missile—was launched. It was followed in 1934 by the A-2, a missile twice the weight of the A-1.

In 1937-1938, a special development and research station was set up at Peenemunde at the great cost of 300 million marks. Here work was continued on the "A" series of weapons, of which we know best the A-4 or V-2 for its extensive operational use during the period from September 8, 1944, to March 27, 1945.

It is interesting to look for a moment at the development of the A-4, for it typifies the course of such scientific work under enemy direction for which parallels may be found elsewhere. Work started on the A-4 about 1940. It was a scaled-up A-3 which had reached a height of nearly 40,000 feet when launched vertically and a range of approximately 11 miles when launched at an angle.

The initial firing of an A-4 on July 6, 1942, resulted in the new missile rising only three feet and then exploding. Number 2 rose to 16,000 feet and exploded, and Number 3 had a similar ending. Number 4, however, in October 1942, flew a distance of 170 miles, and Number 5 proved so good that it was never found.

It was on the strength of these performances that orders for production in quantity were given before the end of 1942. Then, however, came thirteen failures in succession, attributable to various causes. These early firings of the A-4 furnish a pattern which will be familiar to developmental scientists. Several hundred more were launched in a development program which followed closely the ups and downs of the German fortunes of war.

A Close Call

Hitler watched firings of the V-1 and V-2 at Blizna and Kraków, Poland, in April 1944, and stated that these "secret weapons" were not "the products of dreamers" and that England and the whole world would soon feel the effect of the new weapons. It was not until British and American technicians examined German developments that it was realized how near they came to achieving the boasts of the Fuehrer, how narrow was our margin at the armistice, and what losses a six months' continuation of the war in the ETO could have caused the allies.

In all, some one hundred and thirty rockets, guided missiles, and assorted devices were brought to various stages of development and operational use by the Germans. These were in all fields of offensive and defensive weapons, and the results obtained by only the few which reached the production stage are indicative of the results to be achieved by extended use. A total of

3,165 of the A-4's, which were being manufactured at the rate of 96 a day at the end of the war, were launched against England, Antwerp, and continental targets.

It is estimated that fully one-third of all the aërodynamic research in Germany during the final years of the war was done on rockets and guided missiles. The development of the A-4 alone required *18,000 man-years*. Further, there is one yardstick by which our design engineers may judge their own work and ward off some criticism in the statement that some 65,000 engineering changes were made in the design of the A-4 after the first missile had flown successfully.

The stage reached by these developments is best presented, however, in the evaluation of Dr. von Braun, who was the technical head at Peenemunde, when he said that missile development at the end of the World War II was equivalent to that of the airplane at the close of World War I.

In this country, several trainloads of captured V-2 equipment were moved into the White Sands Proving Ground, N. Mex., where it has been assembled and the V-2's used to carry heavy loads of scientific instruments, radar, telemetering equipment, and even scale models into the upper atmosphere to secure missile data, investigate upper-atmospheric conditions and phenomena, and to obtain aërodynamic data in lieu of supersonic wind tunnel facilities.

The atmosphere of the earth is a very complex medium of which many phenomena were known at low altitudes but little at high altitudes. However, there was no unified presentation of observed characteristics, particularly for high altitudes. In fact, the very presence of the lower atmosphere makes the study of phenomena in the upper atmosphere very difficult.

In this country upper-atmospheric research using the V-2's has been carried on for two years. During this time very important contributions have been made in such fields as solar radiation, cosmic rays, measurement of atmospheric temperatures, pressures, ion density, etc. It is indeed gratifying that such a surprising amount of information has been secured in these few months.

Participating Organizations

There is no one organization that encompasses the entire project. The

Dr. C. F. Green, consulting engineer, Aëronautic and Ordnance Systems Divisions, General Electric Company, and a member of the Upper Atmosphere Research Panel, delivered the following address before the Ordnance Technology Round Table at the Thirtieth Annual Meeting of the A.O.A. held on June 9, 1948, at the Book-Cadillac Hotel, Detroit, Mich.

V-2's themselves are assembled, readied for launching, and launched by the Army Ordnance Department with the aid of the General Electric Company under a contract for this purpose which includes technical supervision and supply of missing parts and of new components where required.

The problems of ballistics and of optical and doppler radar tracking are the responsibility of the Ballistic Research Laboratories of the Aberdeen Proving Ground.

The actual upper-atmosphere investigations are conducted by various agencies, including the Air Matériel Command, involving the University of Michigan and Watson Laboratories, the Applied Physics Laboratory of Johns Hopkins University, the Signal Corps, and the Naval Research Laboratory.

In addition, there are numerous other contributing agencies, including Princeton University, the National Bureau of Standards, Harvard University, and California Institute of Technology. All the work is coördinated through the Upper Atmosphere Panel consisting of members from most of the above-named agencies and institutions.

As a refresher for the memory, the V-2 is slightly over forty-six feet long and sixty-five inches in diameter. Its weight is approximately 9,000 pounds without fuel, and 28,000 pounds with fuel, depending on the load to be carried and the launching conditions.

It is launched vertically and controlled by preset timing equipment in pitch or range direction. It is guided by internal gyro equipment during the burning period of approximately sixty to seventy seconds through electro-hydraulic servomechanisms operating carbon vanes in the blast from the venturi and aërodynamic tabs on the fins.

More than 9 tons of fuel (1,220 gallons of 75 per cent concentration alcohol and 1,220 gallons of liquid oxygen) are forced through the turbine-driven pumps in the burning period of 60 seconds, generating a thrust of approximately 60,000 pounds. The gas exit velocity is 7,000 feet a second.

At the time of fuel burnout, the missile has acquired a velocity in the neighborhood of 3,600 miles an hour at which time the rocket motor is developing over half a million horsepower (since one pound of thrust at 375 miles an hour is equivalent to one horsepower). After burnout, the missile has the path of a projectile because control surfaces are placed in neutral position at that time. The V-2 missile carries a pay load of 2,000 pounds or slightly more which makes it possible to install a great deal of equipment and many instruments on each firing.

Securing Data

Information from flights is secured by several means. The path is tracked optically and by radar using a beacon in the missile. Data from the instruments in the missile are telemetered to ground stations over numerous channels (ranging from twenty-two to sixty-eight per flight) and by records, film, etc., which are recovered from the region of point of impact.

To aid this recovery, explosives are used to break up the missile into parts, blowing off the war head and possibly the tail portions. Special parachutes may also be used. Analysis of the data secured on a single flight often consumes weeks of time. Special beacon receivers are installed in the missile to cut off the fuel supply during flight should its trajectory be such as to endanger inhabitants on impact.

Some 35 V-2's have been used in this work with a maximum altitude to date of 114 miles. The number of successful

flights has been greater than anticipated, particularly when one considers that the major portions of these missiles are more than three years old, that storage facilities range from the desert out of doors of New Mexico to enclosure in warehouses.

Many components are now being replaced entirely by American manufactured parts due to these conditions. The training of units in the maintenance and handling of missiles has become a vital factor in such a program.

We must reform some of our concepts and alter previously adopted data based on the information acquired from these flights. But much is yet to be done, for firings at 2-week intervals in which only a few minutes (three to six at most) are available for observations can furnish only scattered readings in a few of the large number of fields in which data are required. So fundamental are the investigations of the upper air that extensive programs are needed to carry on this work.

These outstanding research and training projects are but a portion of the effort of the country to attain a foremost place in this field. In general, the field of rockets and guided missiles involves more branches of science than any other field today with the possible exception of nuclear energy.

Essentially the same performance is required of the missile as is now secured from a fully manned B-29 or submarine—reaching out long distances, locating a target, and then demolishing it. However, add to these the problems of a missile system with ability to handle stationary and movable targets, with ability to handle more than one missile at a time, with freedom from enemy jamming, and, above all, with an accuracy at the distant point of impact equivalent to that of artillery fire and one can justify the great effort that is being put into this field.

A Truly National Effort

Never before in peacetime in the United States have scientists, engineers, industrialists, and public servants—in uniform and out—joined together in so truly national an effort. Never has there been in peacetime such free exchange of information and data and such mutual assistance in the solution of problems.

Developmental work in the field of rockets and guided missiles is proceeding at a pace today that places it in the front of technical and scientific advances of all fields. Thorough and careful investigation of the underlying theory and principles of operation in smaller equipment before proceeding to larger has had the advantage of steady progress with the assurance of good performance when greater power is necessary.

Rocket motor development and design have realized marked improvement through thorough investigation of combustion chamber, throat, and venturi geometry; through means of fuel mixing; through heat-transfer studies and control of reactants. Actual values of specific impulse approach nearer and nearer the calculated theoretical energy values. Much of this work is greatly aided by steady, careful improvement in instrumentation, particularly in the reduction of measurement errors.

New fuels are entering the field and being evaluated from the standpoint of available energy, means of handling in combustion, and general applicability.

All wind-tunnel facilities of the country are today taxed to capacity to furnish needed data immediately and are scheduled for long periods ahead. There appears to be little relief from this backlog and load of future work.

It is interesting to note that much of this overload might be taken by another field if it were prepared to handle it today; *i.e.,* the computing machine field, but unfortunately it is even less able to help because of lack of equipment, either as computing machines or simulators.

The field of guidance and control of rockets and missiles looms great in importance since experience has shown that most difficulties and disappointments have come from inadequacies in this field. There is no point in developing expensive and complex equipment to obtain "near misses." Many systems are available to the designer from the list of preset, course-seeker, beam-rider, command, and homing types, but with each must come consideration of adaptability, accuracy characteristics, inherent limitations, etc.

The accuracy of a V-2 firing against London or Antwerp is no longer adequate even for its range of 180 to 200 miles, not to mention the really long-range missile. To secure these higher accuracies, guidance and control equipment, including radar, gyros, accelerometers, computers, and servomechanisms, must be greatly improved.

The antiaircraft missile for use against high-speed aircraft presents problems in early warning, search, acquisition, data transmission, missile control, war head, etc., for which various means are under development and test.

Antimissile Missile

In the light of the best that was accomplished during World War II against the V-2, there are those who hold that the antimissile missile is nearly an impossibility. However, study has shown that this problem has certain solutions in the devlopment of special and advanced equipment. It is here that speedy transmission of data is so vital, and it is interesting to note that the methods of digital computation offer a new approach to this problem as well as furnishing a means of prediction and computation.

The guided-missile engineer is prepared today to go even further than long-range missiles bound to the earth. He envisions vehicles that because of their high velocity at a fixed altitude become satellites of the earth.

Such an orbital satellite flying at an altitude of 100 miles would complete a circuit of the earth every hour and thirty-three minutes. Another at an altitude of 1,000 miles would complete the circuit every 2 hours and 13 minutes.

The basic principles for the development of such vehicles are known, and only funds and time are necessary for them to become realities.

When one asks if these out-of-the-world vehicles have any useful place other than as cruising missiles, one can point to them as possible relay stations. Four 1,500-mile-high orbital satellites properly spaced would make it possible to reach any inhabited spot on the earth from any other through line-of-sight radar or radio means, thus making them relay centers for television, broadcasting, or remote control.

But of more immediate interest to all of us are the facts that ground-to-ground, ground-to-air, air-to-ground, and air-to-air missiles are coming into being in this country—that defensive and offensive weapons are on the way.

International News

Ground-to-Air Defense

Antiaircraft Artillery Has An Assured Place in America's Forces

by

Preston R. Bassett

"The key to a perfect antiaircraft weapon system is the elimination of the one unpredictable element—the human factor."

THE military airplane and antiaircraft defense were born together. No sooner did an enemy airplane fly overhead than something was improvised to shoot at it.

At the beginning of World War I, airplanes flew at altitudes under 2,000 feet, and those guns that could be trained at high angles were fired in the same manner that a hunter would fire at a duck in flight, that is, by estimating the range and lead angle. It did not take the first fliers very long to realize that they were quite safe from this type of fire.

Very quickly, however, plotting boards and slide rules were devised and put into use that made antiaircraft fire actually dangerous to the primitive types of airplanes flying 60 to 70 miles an hour.

As soon as there was control of antiaircraft weapons even by these crude methods, pilots began to fly higher in order to avoid the fire. This illustrates the fact that antiaircraft artillery primarily denies the airplane the use of certain altitudes and forces it to avoid specific areas or to use less desirable altitudes. The airplane has always carried on by moving to a higher altitude which had an acceptable calculated risk.

Before the first World War was over, the fundamentals of antiaircraft defense had taken a pattern. The slide rules and plotting boards had become mechanized sufficiently to be packed in a box which was called a predictor, around which stood a number of operators reading charts, putting in data, and matching pointers.

New Techniques

The information from the predictor was telephoned to the gun pointers and fuze setters. Special antiaircraft searchlights had been built which would operate at high angles, and various techniques had come into practice for seeking out and following airplane targets at night.

The first crude sound locators had been developed to assist the searchlights, again using telephones to guide the searchlights. It was with these crude improvisations that antiaircraft became organized as a definite and important function of the ground forces.

After the Armistice in 1918 there was a period of six or seven years of stagnation which we could say was caused either by war weariness, lack of appropriations, the wave of disarmament, or, to some extent, by a combination of all these peculiar psychological effects.

It was not until 1924 that there was a general realization that antiaircraft, as a branch of the military, should be modernized and organized in a way to meet the ever-improving airplane.

The development of antiaircraft can be divided into three definite periods which are almost discontinuous and could be called three separate phases in the progress of the art. The simplest way of designating these periods chronologically is (1) pre-World War II, (2) war, (3) postwar. Functionally, however, these three phases should be designated as, (1) component development, (2) revolution, (3) integration.

Component Development

The prewar era was the period of component development. The Ordnance Department went to work on modernizing its 3-inch antiaircraft gun. At Frankford Arsenal, Maj. W. P. Wilson initiated the development of the first predictor based on rectangular coordinates. The Engineer Corps started the development of the portable 60-inch antiaircraft searchlight. Another branch of the Ordnance Department developed the sound locator, and the optical section of the Ordnance Department started on the very difficult job of developing a stereoscopic height finder.

Each one of these components had a most interesting history of development as each succeeding year brought forth improved models within the scope of the meager appropriations which were then available.

No sooner, however, did the components get to the point of functioning satisfactorily within themselves than the problem of properly transmitting the information from one to the other came to be of prime importance. So electric data-transmission systems from height finder to predictor and from predictor to guns, and comparators for coördinating searchlights and sound locators and tracking binoculars all came in for intensive development.

During the period of the 1930's, the bombing airplane was not marking time. From year to year, as the peacetime maneuvers and drills were carried out, the bombers flew faster and higher. They were continually taxing the performance of the antiaircraft units to their limit.

Sound Detection Failed

The bombers were flying so high and had to be picked up at such a great slant range that the sound locator could hardly hear them and could not distinguish their noise above the surrounding noises. In other words sound, as a pickup signal, was letting us down.

The next limitation was that at these high altitudes, with frequent layers of haze intervening, the searchlight was running out of range even though its candlepower had been brought up to over a billion. Increasing the candlepower to three or four billion did not increase the range at these distances since the extra light illuminated the atmosphere instead of the target.

To further complicate matters, the method of determining the range of the airplane by means of the elaborate optical instrument, called a stereoscopic height finder, was proving unsatisfactory at the long slant ranges. Not only was the instrument itself a very delicate one, but it also depended on special observers with stereoscopic aptitude and a great deal of special training. Even then it was found that observers varied in their ability from day to day.

The necessity of utilizing this erratic data as input to the predictor gave the predictor an impossible job. The guns needed smooth data for continuous firing, but the erratic inputs meant even more erratic outputs. There was an urgent need for a new function within the system. There was need for a "smoother."

The reasons for smoothers now have changed with the changing of conditions and equipment.

There was, however, in its extreme infancy both in this country and in England, a new physical basis for obtaining detection signals. This was radar.

The British utilized this secret tool in the critical Battle of Britain by the amazing interception of German night bombers by their night fighter planes. Both the British and ourselves used it to good effect not only in antisubmarine warfare but ultimately in antiaircraft.

The disadvantages, of course, were the tremendous problems of developing radar—forcing science and industry to create an entirely new tool and get it into immediate production without any background of experience in the middle of a war.

Here we should give credit to the splendid work done by the group of scientists at the Radiation Laboratory, at some of the industrial laboratories, and in the electronic manufacturing industry that took on the production of these hastily designed units.

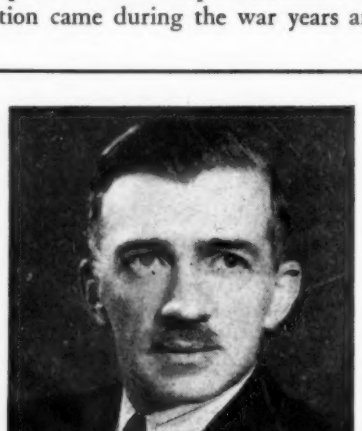
The First Radar

Radar came into the antiaircraft picture in the following important sequence of steps. First came the long-range warning, which eliminated the sound locator, followed by radar ranging, which used very accurate echo timing of radar pulses.

In quick succession there followed radar tracking, which made possible tracking through overcast; tracking at night, thus eliminating the searchlight; and, finally, tracking which supplanted optical means. This gave great impetus to the effectiveness of antiaircraft fire.

Simultaneously with the radar revolution another fundamental change was taking place. This was caused by the rapid strides made in the development of servomechanisms and power controls.

It was not until electronics, the introduction of rates, and lightweight but powerful hydraulic motors were available that a satisfactory gun control could displace the human operator. This revolution came during the war years and at the close of the war all our larger antiaircraft guns had automatic power control.



Preston R. Bassett, president of Sperry Gyroscope Company, delivered this address to the Ordnance Technology Round Table at the Thirtieth Annual Meeting of the A.O.A. on June 9, 1948, at the Book-Cadillac Hotel, Detroit, Mich.

Now, let us add to all this one more revolutionary device developed entirely during the war—the proximity fuze. Fuze-data transmission, the fuze setter and its operator, the uncertainties caused by dead time of setting the fuze, all dropped out of the picture at once.

Statistics are in many cases somewhat meaningless and very difficult to analyze. Nevertheless, some figures are interesting.

When a battery was well equipped and the personnel well trained some remarkable performances were turned in. Perhaps a record was set by the Marine battery in the Pacific which shot down, in one day, 14 Japanese bombers flying at altitudes of 20,000 feet or higher with the expenditure of only forty-four rounds of ammunition.

Or take another case quoted by Lieut. Gen. L. H. Campbell, Jr., where an Army battery in one month had the record of bringing down 16 aircraft with the expenditure of only 50 to 60 rounds per aircraft at altitudes running as high as 27,000 feet.

To quote another outstanding achievement, in certain sectors antiaircraft fire brought down ninety-three per cent of the buzz-bombs before they reached their destination.

But, all of these cases are exceptions—the conditions were ideal, the crews exceptionally well trained. If, on the other hand, we take an over-all average, I suspect it would be found to be still several thousand rounds per airplane. No one has yet found any basis for quoting a definite figure.

Independent Components Used

The fact remains, however, that the wartime antiaircraft systems were still made up of independently developed components, each one designed to carry out its own function as well as possible and only secondarily to work with the other units of the system.

Very frequently the matching of the units so that the output of one was acceptable as the input of the next one had to be worked out under the stress of actual field experience. For example, the output of any piece of apparatus will have a certain unevenness or a certain type and frequency of perturbations. It may well be that the apparatus that this is fed into has a critical period at about this frequency of perturbation,

or it may have been designed to smooth perturbations of quite a different frequency.

It was, therefore, apparent to all the experts in the field that, in spite of the remarkable improvements made in wartime antiaircraft, there was room for much more efficiency by properly integrating the components of the system or by putting the responsibility for a system design into the hands of a single group of engineers instead of several groups each responsible for a component.

There are many other instances where an integrated design of a system can greatly improve performance and accuracy, but we must not overlook another advantage of the integrated system.

The time factor has now become so small for all the operations involved that the human link, which appears to be the only unchangeable factor in the whole problem and which is a very erratic one, has become more and more the weakest link in the chain of operations until it is quite apparent that it must be dropped out of the sequence.

The Human Factor

The following statistics of the number of men that were inserted in the whole series of operations give some idea of the progress in this direction. In World War I there were about twenty men inserted in the sequence of functions from search to firing. By 1935, with components well developed, there were still eighteen men in the chain at night and twelve men by day. At the beginning of the war, there were still ten men, but during the war years with radar and gun control the number fell rapidly to three or four. All that can be said now is that those few remaining must also go.

In the prewar years, such success as was achieved was possible because the targets to be engaged by earlier weapons had speeds that were relatively slow compared with the time-determining factors in the components of the system. For example, shell velocity far exceeded airplane velocity when airplanes flew at speeds less than 200 miles an hour. The ratio was over seven to one.

Alerting times for a battery involving many minutes were acceptable under the same circumstances. The time required to acquire the target and carry out tracking operations similarly was such as to present no great difficulties.

International News

This prewar sound locator was made obsolete by modern-designed combat planes.

With the advent of targets of significantly increased speeds, many factors which were heretofore of little consequence assume importance and must be taken into account.

The ratio of projectile to target speed has already fallen to 2½ to 1. The maximum reliable operational range of early-warning radar against enemy targets determines the permissible over-all time available to an antiaircraft battery. With the greatly increased speed of approaching targets, not much time is allowed.

It becomes necessary, therefore, to shorten drastically the time consumed in carrying out the various operations within the entire system in order to fire with a high probability of bringing down the enemy target. Thus procedures involving voice communications are out of the picture.

In fact, it becomes necessary to devise a new and improved means for target acquisition, and in so doing almost all parts of the system may be affected. In such an analysis, one fact pointedly revealed is that antiaircraft systems must be designed for specific antiaircraft rôles. That is to say, fire-control systems must be designed around the caliber, range, and lethalness of the armament which it is to control. Though the basic objective is the same in many respects for a long-range antiaircraft fire-control system and short-range weapon, the similarity ends there.

Time of the Essence

In any antiaircraft system, the question of time must now be analyzed to see how it affects all parts of the operating sequence. A detailed analysis must be made of all sequences from the standpoint of early warning, target acquisition, settling time, down through the actual firing time available. It must also be borne in mind during these time studies that for all practical purposes target speed is increased to the point where the probability of successful engagement is limited only to the incoming leg.

In the development study we cannot dismiss the fact that there comes a point where the airplane breaks away from its orthodox pattern and suddenly comes in at very low altitudes and very high speeds, counting on the element of surprise and almost eliminating the use of antiaircraft weapons by reducing the possible time of engagement to less than the normal time of slewing the gun onto the target.

There has even been a feeling of futility that this job is too difficult to be solved adequately. Here I think we can sound a very encouraging note. With the elimination of the human links and with the use of all the new electronic tricks for very rapid signals, solutions, and response to signals, the low-altitude antiaircraft artillery will make even more surprising strides than the high-altitude. It will, of course, take new types of radar and a completely new set of numbers for such things as slewing rates, acquisition time, and similar factors.

Solution in Sight

Now, with the possibilities of eliminating human operators and utilizing high-speed acquisition, tracking, and computing techniques, it at last appears possible to solve the short and medium-range antiaircraft systems.

I must conclude this rather rapid survey of antiaircraft with the opinion that its future is assured. It has made remarkable progress through the two phases of (1) component development and (2) the radar revolution. It promises further immediate improvement in this present third phase of integration of components.

Although less spectacular and receiving vastly less appropriations at the present time than the activity surrounding guided missiles, effective antiaircraft artillery can be made available immediately and can be applied to a large number of important new tactical situations. It is difficult to foresee the time when such equipment will be superseded by guided missiles. For a long period yet to come the two types of weapons will supplement each other.

Posts of the A.O.A.

Nationwide Organization for Peace Through Strength and Preparedness

by
Herbert A. Gidney

The Posts foster greater interest in ordnance through meetings, plant visits, seminars, and reports

I WELCOME this opportunity to discuss the status of the local Posts of the American Ordnance Association throughout the country. I have been privileged to work with the Ordnance cause for thirty years, first becoming associated with it on May 1, 1918. I have retained my enthusiasm all through these years because I have been attracted by the ability, the practical experience, the qualifications, and the integrity of all you men.

Colonel Gidney, vice-president in charge of local Posts of the American Ordnance Association and executive vice-president of the Gulf Oil Corporation, delivered these remarks during the Thirtieth National Meeting of the A.O.A. at the Book-Cadillac Hotel, Detroit, Mich., on June 9, 1948.

As many of you already know, the Association endeavors constructively to keep alive an interest in and promote knowledge of the design, production, and maintenance of armament—using the term in its broadest sense to include weapons, their ammunition, and all other special equipment used by our armed forces—land, sea, and air.

As one of the vice-presidents of the Association it is my particular function to have general supervision of the activities of the local Posts and foster their success in every helpful way that I can; to help in the establishment of new Posts and their community groups, known as chapters, as local interest may justify; and to broaden the influence and effectiveness of our Association's plans for industrial preparedness through the medium of these local organizations.

Purpose of the Posts

Broadly speaking, the general purpose of the Posts and their chapters is to cultivate a more intimate understanding of ordnance subjects through regional meetings, plant visitations, seminars, and reports on particular ordnance problems.

On behalf of the officers and directors of the national Association, I want to thank Robert L. Biggers, who, as president of the Michigan Post, has borne a tremendous share of the burden that Post has had to assume in the planning and organization of this Thirtieth National Meeting.

Ever since becoming a member of the Association, Mr. Biggers has rendered yeoman service to the Ordnance cause. His constructive work and genial personality have always been an inspiration to me as well as to all those who know him and who have come in contact with him.

The organization which he and his associates have established here along very comprehensive lines might well serve as a pattern for some of our other Posts whose officers are striving to broaden the usefulness and stimulate the interest of their members.

I congratulate the members of the Michigan Post on their sterling leadership, unbounded energy, and steadfast example. In saying this, I do not mean to imply that any of our Posts are below par, but we all can profit by the good example of successful organizations.

I commend to your attention the May issue of ORDNANCE magazine which contains a most interesting article by Mr. Biggers setting forth objectives for 1948. He was speaking, perhaps, of the Michigan Post, but they will apply throughout the country.

Objectives

In essence, these objectives may be summarized somewhat as follows:

1. Maintain and improve the membership, bringing into active participation capable young men who will likely be heads of industry in any emergency ten to fifteen years hence;

2. Provide adequate, constructive, and interesting activities to justify a large and active membership of doers through a full-scale military demonstration of logistic and tactical progress by the combined forces, and an annual banquet and business meeting.

3. Of a more informal nature, there should be arranged throughout the year several meetings on pertinent industrial and military subjects led by qualified members of industry and the armed forces, bringing together interested sections of our membership.

I would like, also, to mention the activities of our Chicago Post which has a special committee on student members under the direction of Col. William Ryer Wright.

Many of us have realized the vitally important rôle of our younger men in the future welfare of our country. Unless we obtain and hold the interest and support of our younger men of promise, especially in the secondary schools and colleges where their ideas are being formed, there is grave concern as to whether the Ordnance cause, as well as other movements for preserving our freedom and strength, can long survive.

Colonel Wright has given a great deal of time to the preparation of a manual for student members which will be ready shortly for distribution to the officers and members of all Posts.

Thereafter it is hoped that each Post will establish a special committee to

foster the inauguration of student chapters in schools and colleges within their areas, to help young men get a better understanding of scientific and industrial problems and of what preparedness really means, and in helpful ways to guide them in the right path of success in science and industry.

There is also in preparation a manual for the guidance of all our local Post officials which will describe in detail the procedure now followed by the National Headquarters in obtaining new members, maintaining current memberships, methods of billing, information regarding publications, and suggested programs of activities, thus coördinating the activities of the National Headquarters and local Posts throughout the country.

Roster of Posts

In order that you may have some idea of the age and regional location of these Posts, I ask your indulgence while I read the roster of them in the order of their founding:

New York, June 15, 1921; Massachusetts Institute of Technology (Cambridge, Mass.), January 20, 1922; San Francisco, October 17, 1923; Chicago, May 3, 1924; Yankee (Boston, Mass.), June 30, 1925; Washington, November 18, 1925; Cincinnati, December 10, 1925; Philadelphia, December 9, 1926; St. Louis, January 18, 1927; Pittsburgh, February 24, 1927; Milwaukee, September 26, 1928; Birmingham, December 3, 1930; Los Angeles, May 27, 1936; Empire (New York), April 29, 1938; Lehigh-Bethlehem, November 15, 1939; Cleveland, October 25, 1940; University of Michigan, February 20, 1941; Hartford-Springfield (Lyme, Conn.), November 18, 1941; Rocky Mountain (Denver, Colo.), June 10, 1942; Texas (Houston), October 30, 1942; Michigan (Detroit), December 12, 1942; Puget Sound (Seattle, Wash.), January 25, 1944; Nebraska (Omaha), June 22, 1944; Aberdeen Proving Ground (Maryland), August 16, 1944; Mid-Continent (Tulsa, Okla.), December 12, 1944; Northwest (Minneapolis, Minn.), March 15, 1945; Quad Cities-Iowa (Rock Island, Ill.), May 28, 1945; Central Illinois (Peoria), May 29, 1945; Lone Star (Dallas, Tex.), June 12, 1945.

You will note that the New York Post—with an enviable record of accomplishments—is the oldest on the list, being formed June 15, 1921—less than two years after the Association was organized.

Our youngest Post—founded June 12, 1945—is already a healthy, growing organization, located at Dallas in that great State of Texas and is appropriately known as the "Lone Star" Post.

Our country needs and welcomes the active help of these leaders of industry. You will find the full list of the management of each Post in each issue of ORDNANCE magazine.

The founders of this Association were wise and prudent men of great experience who realized that no matter how sound might be the principles and objectives of the organization on a national scale, the ultimate strength of any society such as ours depends in the final analysis on the nourishment and accomplishments which come from the grass roots.

It is the young men of industry who must carry on the ordnance cause.

We have superior publications, timely and worthwhile seminars, inspiring national meetings such as this one now in progress and the meeting at Selfridge Field tomorrow.

Assist the Fighting Forces

Through these gatherings we make interesting contacts and accumulate indispensable sources of advice, counsel, and experience which aid all official representatives of the Association, local and national, to assist constructively the leaders of the fighting forces of our Nation in solving their armament problems.

Without this firm support in all scientific and industrial areas throughout the country this Association would not rest on such sound foundations as now support the officers and directors and other representatives who are carrying the torch for the Association.

We can look with pride to the achievements of our Posts which are performing such vital functions in strengthening our national organization which is striving to preserve the peace.

Speaking for the other national officers and directors, we have the highest praise and gratitude for all that our Posts have done and are doing for the Ordnance cause.

I congratulate the officers and directors of all Posts individually for their unfailing assistance and urge them to redouble their efforts.

Now, just a word regarding the activities of our National Headquarters. Being modest men, you do not hear much about the doings of your national officers.

I would like to say that this Association is very fortunate in having at its head our genial president—Col. Jim Walsh—one of the founders who, for thirty years, has been an enthusiastic director of the Association and a leader in ordnance affairs.

Then we have Harvey Knowles, our vice-president, who has done a major service in organizing and supervising the general activities of all our National Divisions on technical phases of ordnance work. You who saw something of his work this morning know his tact and the wonderful way in which he has developed the Divisions.

Then we have our good old wheel horse, Col. Leo A. Codd, executive vice-president, who is here, there, and everywhere where American Ordnance activities are going on.

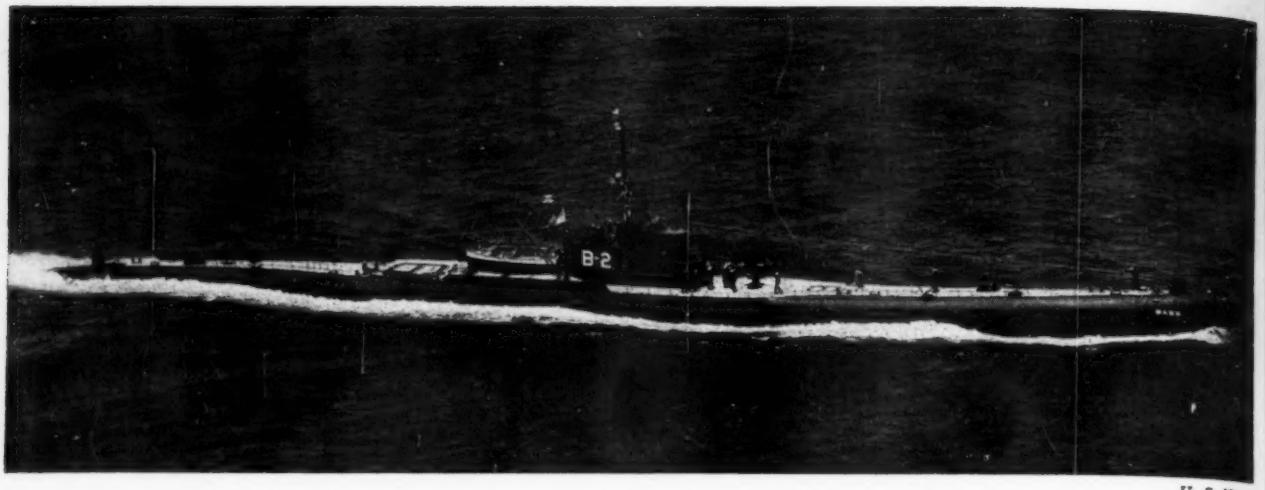
These men have traveled thousands of miles to all sections of the country, participating in the meetings of the local Posts, appearing before business groups, and in every way furthering the objectives of the Association and cooperating to the fullest extent with the representatives of the Army, Navy, and Air Force.

Broad Horizons

Under our present title of American Ordnance Association we now have the broadest horizons and objectives—promoting useful services for the national defense without lessening our services to the Army, with which we formerly were primarily concerned.

We have continued our service to the Air Force which has branched out on its own, and have extended our service to the Navy, thus coöperating with all agencies which are interested in the common defense of our country.

We advocate integrated coördination and long-range planning with due regard to the peacetime economy of our country. To that end we, in industry, must all pull together to serve our Government wisely and thus promote the primary purpose and aim of our Association, "To keep America strong for peace."



U. S. Navy

Undersea Warfare

Trends in Submarine Attack and Counterattack

by

Rear Adm. C. B. Momsen

"Our submarine war in the Pacific is the first instance in history of a successful submarine campaign"

THE art of submarining has had a spotty history. The first actual submarine that was made and operated as such was built by Cornelius van Dribel, a Dutchman. In 1620 he made a demonstration in the Thames River before royalty and members of the British armed forces.

This small craft was made of wood with oars stuck out through holes in the side that were made watertight by goatskin covers. The British were very much impressed and even in that day somewhat apprehensive of this new device.

During our Revolutionary War, David Bushnell conceived the idea of a submarine making attacks on ships anchored in the harbors, and in an attempt to drive away the British fleet, which was anchored in New York Harbor, he built a small submarine. He crawled out in this thing during the night and attempted to fasten a mine to the hull of a British frigate.

He was unable to penetrate the bottom and attach the mine which drifted downstream and exploded. But the British were sufficiently alarmed and they changed their anchorage into the lower harbor the following day.

Submarines In the Civil War

During the Civil War, the Confederates developed small submarines, manned by one or two men. These were called "Davids," and with these small craft they attacked the Federal ships in Charleston Harbor. One, I believe it was the IRONSIDES, was damaged, and the old HOUSATONIC was sunk.

Unfortunately, the heroes of these Civil War submarines were all lost, and we were never able to get a complete account of what happened.

About 1866 John Holland started building submarines. He was the leader of a group of Irish-Americans who wanted to build submarines because they thought that eventually the submarine would be the means of destroying British seapower!

John Holland built several undersea craft, but he did not have too much success with them in those days. Money was coming in, however, and he was able to continue his experiments although his first submarine never actually operated.

His second one was a disappointment. He sunk it in the Passaic River in New Jersey. However, later on he built one that looked promising and sold it to the United States Government for about $150,000. That one never operated successfully, and it wasn't until 1900 that the first Holland submarine was actually built under naval specifications. In April 1900 the modern submarine was born.

The reasons that submarines had not been built successfully prior to that time were threefold.

In the first place, they were unable to be steered on a given course because the magnetic compass would not work well under water. Secondly, they did not have any means of propulsion except man power because there were no engines adaptable to submarine construction. And in the third place, they had no motive power for operating submerged.

New Developments

Toward the turn of the century, the storage battery was developed to a point that met the requirements of a completely submerged vessel and has since been the most essential part of the submarine propulsion plant.

The gyrocompass came along and gave the submarine a means of finding its way submerged, and, of course, the gasoline engine was developed, but it was a terror to submarines because of the gasoline fumes and the danger of explosion. The gasoline engine was replaced by the Diesel engine during World War I.

During the development years of the submarine, various countries took the lead.

I think that we started it in 1900. France picked up the idea very quickly because they had always felt that British sea power was a thorn in their side, and they wanted to find some cheap and easy way of combating it. The British then came along and took the lead for a while.

It was about 1911 that the Germans started developing submarines, and in August 1914, when the U-21 sank four British cruisers in one day, modern submarine warfare began.

1,500 Ships Sunk

I do not have to tell you what happened in the submarine campaign in World War I. Briefly, there were something like 1,500 ships sunk, and losses in money and men were terrific.

The submarine warfare of the Germans had the British rocking and almost on the verge of defeat. It was not until their scientific and industrial people got busy and applied their entire effort to developing antisubmarine measures that they were able to cope with it. Of course they received a little bit of help from Uncle Sam!

The World War I submarine was finally brought into check by means of surface ships. There was very little air action against the U-boats in that conflict.

During the time between World War I and World War II, there were a great many developments in submarines and in antisubmarine warfare. Methods of detection, fire control, and weapons underwent great development.

We were very fortunate when World War II started in that we had a submarine prototype that was perfectly suited to our war in the Pacific. The war in the Atlantic consisted mainly of defensive action on our part rather than an underwater offensive.

Our submarines were air-conditioned. They were of long range. They had fine torpedoes. They had effective guns. They had good listening gear. They had the sonar and the fathometer. All this new technical equipment was in being, at least in prototype form, when the war started.

Our submarine war in the Pacific is the first instance in history of a successful submarine campaign. We do not claim that submarines won the war. We only claim that we held up our part of the team.

In the Pacific, the Japanese, who had been imitators ever since they started on their development as a modern nation, had everything that we had up to the time that war started. But having obtained their progress by borrowing, or otherwise, they had not developed the know-how, the inventive genius, and the means of research that we had, and their progress stopped.

Therefore, when the war first opened, we had considerable difficulty in getting by their escorts because combat followed much the same pattern as World War I—escorts versus submarines. In addition to that, they brought in their air arm, and that caused us a lot of trouble in the first year of the war.

However, our results were good, and as we continued to get new gear, the Japs fell behind because they could not keep pace with our developments. If you ever saw a case of shooting sitting ducks, it was our submarines operating with radar against ships at night which had no radar.

Our submarine people became so proficient that they could sleep in the daytime and just let things go, following their targets and waiting until it got dark. Then it was just like walking in and reading the other fellow's cards. He didn't have a chance.

Toward the end of 1943, when our submarines torpedoed a ship in a convoy, the escorts would run in the opposite direction. They wanted no part of that.

It was different in the Atlantic. The German submarine development was not only more rapid than ours, but they had also prepared themselves a little bit better. But they were faced with an antisubmarine warfare campaign—destroyers and air—that was pretty tough.

Rear Adm. Charles B. Momsen, Assistant Chief of Naval Operations (Operations), delivered this address during the Industrial Preparedness Luncheon of the Thirtieth National Meeting, American Ordnance Association, at the Book-Cadillac Hotel, Detroit, Mich., June 9, 1948.

As a consequence, they developed devices that we did not find necessary to develop in the Pacific. I refer to higher-speed submarines and that device that you hear so much about—the *Schnorkel*. The Schnorkel is nothing but a breather pipe that reaches up from the hull to the surface and takes in air for operating the internal-combustion engines. With it submarines can recharge their batteries while submerged with nothing but the little head of the Schnorkel sticking up above the water.

With the invention of the Schnorkel, which fortunately was near the end of the war, it became very very difficult for airborne radar to pick up a submarine for it could remain submerged for long periods of time—in fact, during an entire patrol. We ended the war with this problem of combating the Schnorkel unsolved. It is a problem that must be solved in the future.

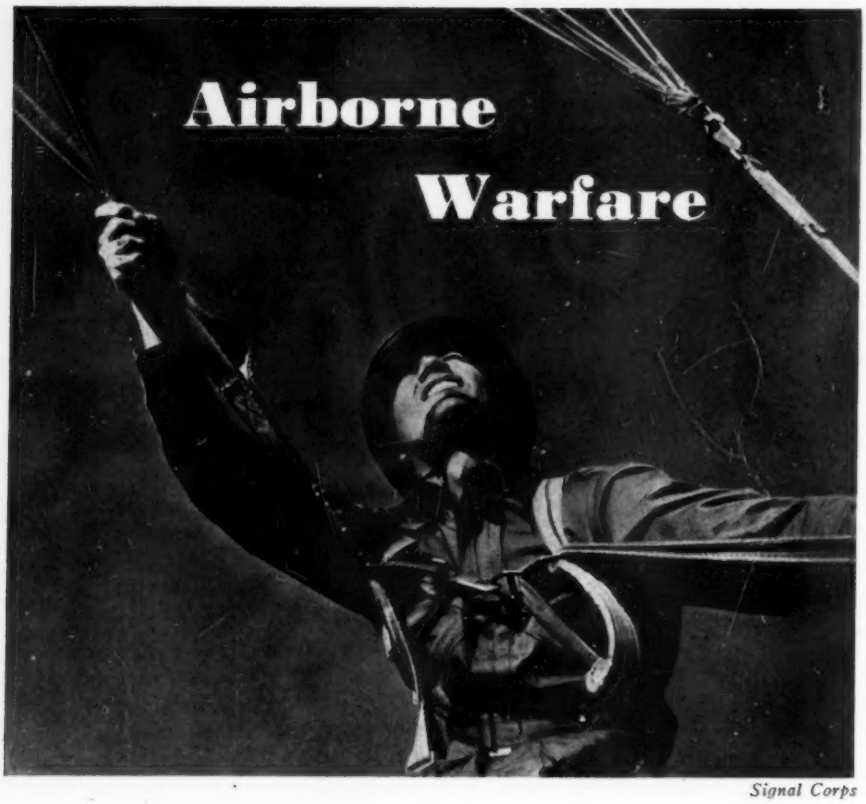
It may seem, perhaps, that undersea warfare would not have any commercial counterpart as does aviation or shipbuilding, but I believe that it does.

Undersea Knowledge

The knowledge of the bed of the ocean, the knowledge of the temperatures of the water, of the currents and tides, is all valuable information that new devices used in submarines have permitted us to get. Much valuable information has been obtained with regard to the bed of the ocean, and even now we find oil wells being drilled in the Gulf of Mexico and off the coast of California. Oil companies are also exploring banks way out at sea.

I am sure that as time goes on—not perhaps in our generation—we are going to see the peoples of the world moving out more and more over the water for useful pursuits, and I think that our undersea warfare will make some contribution toward that effort.

The people of American industry who were responsible for our material, for our machinery, and for our ordnance equipment did a splendid job. I think that there are no words to describe it, and I want to take this opportunity to pay my compliments to all who had a hand in doing that job.



Signal Corps

New Types of Equipment Are Needed For Our Victory in Future Battles

by

Maj. Gen. James M. Gavin

"Today we are entering the very vague field of applied air power where there is no precedent"

IT is good to be with you men of industry today, and it is an opportunity to which I have been looking forward, because for some years I have had the privilege of using the products of your inventiveness, ingenuity, and energy. Then, too, I wanted to take this opportunity to tell you the views of many of us in the airborne effort in the hope of stimulating interest in the development of the means to do the job a little better if we are ever called upon again.

I am going to talk to you about airborne warfare—about what it will take to do the airborne job and what we hope we will get to do that job. From the viewpoint of the people who have been associated with the airborne effort, the means necessary to impose the national will on any future adversary must be moved by air. That raises the question, "What is air power?"

Air power, in brief, consists of everything it takes to do the job by air. It is not necessarily bombs or bullets, although it may well be in many or most cases. It is also gasoline, it is men to secure bases, it is technicians, aid men—it is everything it takes to do the job.

I feel we are inclined to forget these things, but remember the Norwegian invasion when the Germans moved 150,000 men into Norway in three days. One of the first things that came out of an airplane at Oslo, the Norwegian capital, was a German band playing the Norwegian national anthem. That was air power, just as much as the bombs dropped at Narvik.

Let us consider one thing I think we sometimes would like to forget. We built some ten airfields in Southeastern China to the tune of $68,000,000. They were put in there on the theory that air attack would stop any opposition that might attempt to take them.

I am sure that many of you can still recall the newsreels showing the billowing black clouds of smoke going up from these installations which were fired when we had to abandon them to the enemy.

Some eight Japanese divisions waited until these fields were all finished—like big, fat, ripe plums—then they moved in and cleaned them out.

What should our forces have had? They should have had the men and the means to hold these bases by air when the threat became evident. The enemy on the ground could have been checked, and then the aircraft could have moved in and destroyed him. But the needed element was lacking.

I read about a month ago that we were putting some $78,000,000 into Alaska. We have twenty-eight major airfield sites up there now. It will take men to hold these bases—men who must be moved in by air when a threat becomes apparent.

$164,000,000 Radar Screen

I also read the other day that the Air Force plans to spend $164,000,000 on a radar screen to protect our country.

If we put $164,000,000 into a radar screen on the outer perimeter of our sphere of national defenses we are going to lose a lot of it unless we have the means to move by air to hold it if attacked. We must move with the proper weapons in the hands of the airborne troops and with everything else it takes to do the job.

One of the first radar stations established by the Germans on the coast of Northern France was at Brueneval. One of the first airborne operations on a successful scale was the parachute operation against that radar station. It was wiped out. It was seized, both for reasons of intelligence and tactical clearing, by British airborne troopers who were then evacuated by submarine.

But if our money is to be put into such a perimeter screen; if it is to be put into fighter bases, interceptor bases, and bomber bases; if we are going to recapture them if lost; if we are going to reënforce them and hold them—then we will have to move our troops quickly and by airborne means to do it.

What means do we have to do such a job?

We have the parachute, the glider, the air transport, and now, coming into great prominence, the helicopter. These are the means which will do the job.

Let us now consider these tools, their application, and how we anticipate using them.

The parachute, for example, is a very inefficient gadget. It is quite old—Galileo first used the parachute. The parachute we now have is not much better than the one used before the end of the war. It is designed to lower a man weighing 175 pounds at a rate of 18 to 21 feet a second from an airplane traveling 120 miles an hour. Our American boys actually jumped that chute with weights up to 250 pounds during the war, and it has been used at higher speeds. But here is the problem with the parachute—and the solution really is in your hands: When a man jumps from an airplane going more than 120 miles an hour, he blacks out. This means that the approach speed of the airplane must be limited.

High-Speed Parachute

To make the chute usable in a higher-speed airplane (and, goodness knows, we must go beyond 120 miles an hour) the thing to do is, let us say, take away part of the silk—cut a hole in it like in a doughnut. Then when the man jumps out, the air rushes through the hole causing little opening shock. Of course, the jumper will come down awfully fast. If you follow this theory, you might take away all the silk and let him jump without anything! There is a limit, obviously, to such a development.

Suppose, instead, that we put holes in the chute that can be mechanically closed. Well, the closing mechanism is another gadget that may cause the chute to malfunction and also cause deterioration and maintenance problems.

But, suppose we do get our troopers jumping at three or four hundred miles an hour, what happens?

When a squad jumps from a 120-mile-an-hour airplane they just about stay in the same back lot. At 400 miles an hour they would have difficulty staying in the same county. As a matter of fact, twelve troopers land within a thousand yards; when you triple that speed, the distance is increased to three thousand. Soon it takes them a day to walk back together again after they land!

These are just a few of the practical problems that must be solved, and we must develop the means to solve them if we are to do this job.

The Glider

Let us now consider the glider. The glider enables a greater load to be flown to the target. We have a glider now with a capacity of four tons. That is getting to the point where we can fly in the stuff our American boys will need to live with and fight with anywhere.

Today the glider is towed behind 300 feet of rope and must be protected by fighters. If we got into a Normandy operation, for example, with 1,380 C-47's, or DC-3's we would need fighters up there for hours and hours with a great loss in men, money, and means.

We have tried to bring the glider closer to the transport, connecting the two with a rigid bar. But if we get the glider close enough, it begins to fly the transport—it becomes another flight-control surface.

Perhaps you may say, "Then why not make the glider part of the transport?" We started to consider this possibility three or four years ago, and we received enthusiastic response from some of our aircraft companies. As a result, today we have in development an airplane that permits the fuselage to be detached on landing.

What we would like to do is get an airplane where we could just drop that fuselage with about a platoon of troopers—just drop it free at about 120 or 150 miles an hour about 10 feet above the ground and decelerate it by rockets so that it could land in a plowed field if necessary. This would do away with all the problems of parachuting and attendant dispersion.

As far-fetched as this plan may sound, it is not far away. As a matter of fact, I think it is well within our capabilities. Parachutes, of course, will still be used by the initial assault forces.

In considering the transport airplane let us take the DC-3 that you all know. One great obstacle to its use in the last war was its foot pressure—seventy-five pounds per square inch. You no doubt have seen pictures of the track-laying airplane which has tanklike treads instead of wheels. This device brings down the ground foot pressure to twenty-five pounds per square inch.

During the last war at one time we air lifted 10,000,000 gallons of gasoline by 5-gallon cans and drums, handing them in and out of the doors of airplanes while those planes stood around subject to enemy attack and great loss.

We must design the equipment and the means that will permit the complete packaging of combat cargo—gasoline, food, ammunition, everything—and do away with the thousands of man-hours lost in handling little boxes in and out of the doors of the airplanes, only to find out the damn things don't fit snugly. Then you have to tie them down and spend more hours while the airplane sits on the ground.

Packaged Equipment

Why can't you gentlemen give us everything we need packaged for attachment to the transport and detachment immediately upon landing so that the aircraft can fly many, many carloads?

Those are the things we need. We need track-laying airplanes that can land in pastures anywhere with 10-ton loads. In an operation at Camp Campbell, 72 airplanes landed in less than an hour. Those were 10-ton airplanes—720 tons an hour. A division in the

Signal Corps

Carrying the "tools of his trade," this paratrooper climbs aboard a transport.

This C-82 "Packet" shown disgorging paratroopers is becoming the workhorse of the Airborne, supplanting the C-47 in carrying troops, guns, trucks, and supplies.

Normandy assault needed about 500 tons a day to keep alive, and that is all that could be delivered to them across the beaches. You can give us by airplane, now, more than that in one hour. We must further develop the means to use this great delivery potential.

The Helicopter

That brings us to the helicopter, although its tactical use is not well defined. The helicopter, the dual-rotor type particularly, permits hovering over the surface. What we should have is a helicopter that would permit the handling of cargo containers and their dispersal around the area where the transports land.

The helicopter today is where the airplane was in 1917, but it has remarkable potential, and we must exploit that potential.

The aircraft industry has given us a great deal in the way of new equipment. However, we are still talking about fighting with the same weapons we have used in the past.

Take the big B-36, for example. It is a $20,000,000 airplane. It requires 7,000 feet of 42-inch reënforced-concrete runway. At last reports I think we had four airfields in the United States we could land it on. In terms of moving existing ground-force equipment it will fly a Sherman tank having seven inches of armor plate. You fly that in and risk $20,000,000 to do it. You get it into combat and some soldier knocks it silly with one shot from a bazooka!

The point is that we must develop combat vehicles capable of air movement that will do the job we want in the forward area, and American industry must produce them. We must become weight conscious. We now have folding-stock weapons, light combat rations, and many other items that are air transportable, but we must go much, much further.

We must start right at the soldier himself and what he carries. Everything must be made air transportable—cases of ammunition, quarts of blood plasma. These are the things which keep the fighters alive and not all this excess cargo—not cots, bedding, folding tables and chairs, and all that stuff. The same thing applies to the weapons we are going to need to do the job. There is where the greatest potential field for development lies.

Today we are entering the very vague field of applied air power where there is no precedent; at least on the surface there does not appear to be. However, two important points stand out: First, we are today in a critical period in the evolution of warfare; and, secondly, there is a trend to go by.

When David met Goliath, Goliath pompously stomped forward encased in his corselet, confident that he was absolutely invincible because he had destroyed everything he had met. He knew it, and there was no doubt about it. So, when little David came forward, with nothing but a fleet foot and an idea, he disdained him and spat upon him—and Goliath was knocked silly by a man with agility and punch. Call it maneuverability and firepower, if you will.

The same thing happened to the Grecian phalanx when it was beaten by the Roman legion; the legion when it was defeated by the Huns' fast horses and fine weapons.

We have had that pattern all through history—of mobility and firepower, or agility and punch, defeating the weapons of the past that became inordinately heavy and immobile under then-current conditions of war.

There is something to look to because we are exploiting a relatively new medium in the airborne future—the air. We must develop the means to exploit this medium, and it will take more than bombs and bullets.

We are in a competition, whether we like it or not. We are fortunate that in association with our allies we have developed airborne power to a point that the world has never seen before.

Beyond the Horizon

In the past, we have looked to other nations for the development of many items of ordnance and other military equipment. Airborne, we are out in front. Yet the horizon is there, and we must go beyond it. We must do it if we are going to win this competition we are in. The stakes are high—in fact, are our very way of life. The eventual outcome concerns everything we do, everything we believe in, and everything we want. But give our people the things to do the job by airborne means and they will win the competition.

We were most fortunate during World War II to have had the right weapons to do the job under the conditions in which we fought. American industry gave them to us, and they left nothing to be desired. Our survival as contestants in that conflict testifies adequately that our weapons and other military equipment were second to none.

However, in case we get into another scrap I do hope we will have the means to win it the quickest way—by air.

General Gavin, Chief of Staff of the Fifth Army, delivered this address at the Industrial Preparedness Luncheon during the Thirtieth National Meeting of the American Ordnance Association at the Book-Cadillac Hotel, Detroit, Mich., June 9, 1948.

Ordnance Day, 1948

The A.O.A. Cohorts Visit Selfridge Air Force Base

Association members and guests witness demonstrations of tactics and matériel—land, sea, air

THE Thirtieth National Meeting of the American Ordnance Association was held at Detroit and at Selfridge Air Force Base, Mich., on June 9 and 10, 1948, and was dedicated to the objective: "Keep America strong for peace." The Book-Cadillac Hotel, Detroit, was the scene of the Industrial Preparedness Session on June 9th featuring a host of nationally known ordnance authorities, both military and civilian. The addresses of these experts are published in full elsewhere in this issue.

This session consisted of an Ordnance Technology Round Table in the morning presided over by Harvey C. Knowles, vice-president of the A.O.A. in charge of National Divisions; chairman of the Rocket, Bomb, and Artillery Ammunition Division, A.O.A.; and vice-president of Procter & Gamble Company, Cincinnati, Ohio. This was followed by the Industrial Preparedness Luncheon with Robert L. Biggers, president of the Michigan Post of the Association and president of Fargo Division of Chrysler Corporation, Detroit, as toastmaster.

Following the luncheon, members and their guests were invited to make an inspection of the Chrysler Research Laboratories at Highland Park, Detroit. The Industrial Preparedness Session concluded with the Thirtieth National Dinner Meeting in the Grand Ballroom of the Book-Cadillac with Mr. Biggers presiding and James L. Walsh, president of the Association, officiating as toastmaster.

The Technical and Scientific Session of the National Meeting was held on June 10th at Selfridge. This consisted of a series of demonstrations of tactics and matériel—land, sea, and air—and displays of Army, Navy, and Air Force equipment.

Approximately 5,000 members and their guests arrived at Selfridge from Detroit by automobile, bus, and special train. They were greeted by an Air Force band which livened the short march to the hangar area where the visitors swarmed through interesting displays set up in the hangars and climbed over and under latest types of fighter and bombardment airplanes and Ordnance vehicles on the parking ramp.

It wasn't long, however, before the roar of aircraft engines drew the crowd to the edge of the field where a group of Navy F4U's and jet Phantoms simulated carrier landings, coming in with flaps and hooks down following the wig-wagged instructions of the landing signal officer. When almost on the deck the pilots gave their ships the gun and roared off to circle around and make another pass.

The Army Ordnance Department's heavy tank then took the center of the stage in a demonstration of its mobility, speed, and ease of handling.

All eyes were drawn aloft once more as the Air Force demonstrated recent progress in fighter aircraft, sending up the F-51 Mustang of World War II fame, the F-82 Twin Mustang, the F-80 Shooting Star jet fighter, and the F-84 Thunderjet. The two jets seemed able to fly circles around their reciprocating-engined brothers.

Lakeside Demonstrations

At this point the Ordnance cohorts adjourned for luncheon to the shores of Lake St. Clair which bounds one side of the base. Here, following luncheon, a Navy underwater demolition team put on a very spectacular exhibition. After being dropped by a speedy launch, the team swam under water and affixed demolition charges to a series of landing obstacles guarding the beach. When the charges were placed and the main fuze set the team was snatched from the water by the launch "on the fly" just as the explosives detonated with a deafening roar, completely demolishing the obstacles.

One member of the team was then cast adrift in a rubber boat, and a B-17 of the Air Rescue Service flew over and dropped him a lifeboat. This full-sized boat was released at about 2,500 feet and descended gently on three large parachutes. The "castaway" then paddled to the larger craft and was "saved." But just to make certain he reached shore safely, a helicopter flew out to the boat, hovered overhead, and lowered a ladder. The survivor then climbed quickly into the helicopter and was whisked to land amid the "well-done's" of the crowd.

Here the Ordnance Department also demonstrated a group of its amphibious vehicles—a "swamp skipper," a Duck, and a tank equipped with flotation gear.

Back at the hangar area the Navy was readying a carrier-based air group to take off and intercept a joint Army-Navy-Air Force "assault" on Selfridge Air Force Base. As the crowd returned from the lake front the Navy fighters, parked prop to tail at one end of the parking ramp with wings folded, began to take off. As one ship took off, the next began to roll forward, lowering its wings, and just as the preceding ship cleared the runway the pilot gave it the gun and it was off in a burst of sound. For fifteen minutes plane after plane roared off every few seconds while the spectators held their ears and grinned at this spectacular display of naval air power.

The "attack" on Selfridge began with a "softening-up" carpet bombing by Air Force B-29's from the 28th Bomber Group from Weaver Air Force Base, Rapid City, S. Dak. As these aërial giants droned over they released 100-pound practice bombs on a target across the field from the spectators.

No sooner had the roar of the B-29's died away when a carrier-based air group began a low-level attack on the field. First came a strafing pass by Marine Fighter Squadron 461 from Cherry Point, N. C. Hot on their heels came the dive bombers of Navy Attack Squadron VA-6B from the U.S.S. CORAL SEA. "Top cover" was flown by the Navy Jet Fighter Division VF-17A.

(*Continued on p. 112*)

ORDNANCEMEN A

Present at the exhibition were, left to right: Maj. Gen. Gavin, Gen. McNarney, Gen. Bradley, Col. Hudnell, Capt. Dunlap, Adm. Price, Gen. Kenney, and Mr. Biggers.

As part of the flight demonstrations, a helicopter showe
over the surface while a soldier climbed up a short rope l

On display at the field was this needlelike, sleek, 4-jet bomber, the B-46. One of the newest and fastest of its type, it is powered by 4 turbo jets, spans 113 feet, and is 105 feet long.

Paratroopers of the 82nd Airborne Div
technique of assembling a 75-mm. howitzer d

A.O.A. ordnancemen get a close-up look at the F-84 Thunderjet, one of the Army's jet fighters in the 600-mile-an-hour class, which has been made operational. Of exceptionally clean design, it is powered by one of the most powerful jet engines.

In snatching a glid
towrope from the u

AT SELFRIDGE

licopter showed its rescue functions by hovering a short rope ladder into the cabin of the aircraft.

Mr. Biggers, left, General Bradley, and Colonel Walsh, right, spoke at the Thirtieth National Dinner Meeting the evening before the Selfridge Field session.

Airborne Division displayed the m. howitzer dropped by parachute.

One of the stellar attractions was the intimate view of the FH-1 Phantom, the Navy's powerful and lightning-fast carrier-borne jet fighter which has already completed successful sea trials.

tching a glider from the ground, a C-47 swoops low to pick up the nylon pe from the uprights and whips the glider into the air after a run of a few feet.

The Swamp Skipper was designed to negotiate low, wet ground impassable for most other vehicles.

In case there was still some "enemy" resistance left, the Air Force then sent over a jet fighter squadron from the 56th Fighter Group at Selfridge to make a glide bombing attack on the target. The jets put on a thrilling demonstration, swooping down almost silently at a 40-degree angle, releasing their bombs "right in the barrel" and then zooming up out of sight almost quicker than heads could be turned to follow them. This demonstration brought out clearly the difficulties of defending installations from low-level attack by such swift aircraft and underlined some of the technical talks on this very subject given the day before at the Industrial Preparedness Session of the National Meeting. Besides being thrilled, the Ordnancemen were chilled at the thought of really being on the receiving end of such an attack.

Now that ground "resistance" was broken and demoralized it was time for the Airborne troops to land and establish an airhead to hold the objective against counterattack and get ready for further advances. In preparation for the landing, transports flew over the drop area releasing equipment for the troops, including a 75-mm. howitzer broken down into several parapacks.

Glider Attack

No sooner had the equipment hit the field than gliders of the 316th Troop Carrier Wing from Greenville Air Force Base, S. C., were towed over the field by transports, released their towlines, and soared in to a graceful landing in front of the hangars. Assault troops of the Army's 82nd Airborne Division from Fort Bragg, N. C., poured out, quickly assembled the 75-mm. howitzer, and towed it off to position with a jeep they had brought along in one of the gliders.

Several of the Airborne men were "wounded" in the assault, and preparations were made to evacuate them immediately by air. They were placed in a glider whose towrope was affixed between two small uprights. Then a C-47 transport swooped in low, lowered its "snatch hook," caught the tow line, and whipped the glider with its load of "wounded" into the air.

The "Battle of Selfridge" ended with an aërial review of the experimental and other aircraft previously displayed.

While the air and water demonstrations were exciting and interesting, the static displays in the hangars offered a wealth of information and scientific detail to those who wanted to learn more about the "whys and wherefores" of military equipment. The Army display featured exhibits by the Ordnance Department and the 82nd Airborne Division. One Ordnance exhibit, from Detroit Arsenal, featured different types of combat-vehicle engines together with power trains, tracks and suspensions, and electrical components. Various types of wheels and tires were shown as well as the winterization equipment needed by vehicles operating in very low temperatures.

Aberdeen Exhibit

An exhibit from Aberdeen Proving Ground featured a 105-mm. antitank gun, small arms, ammunition, body armor, strain-gage and velocity-measurement demonstrations. A sound movie of a V-2 rocket take-off and flight also attracted an interested audience.

The Airborne exhibit showed the weapons and other equipment carried and used by paratroops and airborne infantry, including guns, howitzers, mortars, rockets, and small arms. Gliders and various types of parachutes were also on display, not to mention a group of husky paratroopers in full battle dress. These rugged lads, even more than their weapons, made the visitors agree with General Gavin, their old commander, who said at the Industrial Preparedness Luncheon the day before, "Airborne, we are out in front."

The Air Force display featured exhibits from the Air Matériel Command including recent developments in research, power plants, armament, propellers, medicine, photography, testing, and air rescue. Of great popular interest was a small radio-controlled tank which would start, stop, go backward or forward, and turn in circles around the hangar floor, seemingly without human guidance. From time to time a horn in the tank would blow, the turret would pop open, and a dummy gunner's head emerge. The controls for the tank were the same as those used on Air Force drone planes, such as those that flew through the atomic cloud in the Bikini tests.

Also of interest was the exhibit of centrifugal- and axial-flow jet aircraft engines, particularly the cutaway models showing the internal movements of the various parts and the flow of fuel and gases. The Air Rescue display likewise struck a popular note with its array of equipment for living under conditions of extreme hardship in jungle and arctic regions and for saving the lives of fliers—military or civilian—who might be forced down at sea or in unfavorable terrain.

The Navy had displays of matériel from the following naval Bureaus: Ordnance, Aëronautics, Medicine and Surgery, Yards and Docks, Ships, and from the U.S. Fleet.

The Bureau of Ordnance exhibit was from the Forest Park (Ill.) Ordnance Plant and included the "Aërobee" sounding rocket, aërial and standard torpedoes, and a display of gyroscopes and valves used in torpedo construction. Backdrop for the display was a colorful mural depicting the many trades and types of equipment used in torpedo manufacture. Other ordnance items included the new 3-inch 50-caliber twin guns and mount for shipboard antiaircraft defense or surface fire, projectiles, bombs, mines, and depth charges.

The Bureau of Aëronautics provided a comprehensive display of radio-controlled drone aircraft which proved interesting to the visitors as they were allowed to work the remote-control mechanism that operated the elevators, rudders and ailerons, raised and lowered the wheels, and closed various cowl vents and flaps.

The Bureau of Yards and Docks presented a model floating dry dock, while the Bureau of Ships scored with a clear plastic model of the carrier MIDWAY showing its compartmentation.

Colonel Hudnell Thanked

Col. W. T. Hudnell, commanding officer, 56th Fighter Wing, Selfridge Air Force Base, and his staff were congratulated and thanked by the officers and members of the American Ordnance Association for their part in making the Thirtieth National Meeting a success.

After the inspiring Industrial Preparedness Session at Detroit and the Technical and Scientific Session at Selfridge, members of the A.O.A. felt that if the Army-Navy-Air Force-Industry team continues to pull together it will be possible to keep America strong for peace in the years ahead.

For the Common Defense

U.S. and Canada Plan Jointly To Protect Their Freedom

Victor Sifton

8

Victor Sifton is president of the Canadian Ordnance Association and publisher of the Winnipeg Free Press. He delivered this address at the Thirtieth National Dinner Meeting of the American Ordnance Association held in the Book-Cadillac Hotel, Detroit, Mich., June 9, 1948.

IN considering the problems of defending this continent against the dangers of armed aggression and using our united strength to guarantee the peace of the world in association with like-minded nations, one fact stands out above all others:

Unlike in 1919, the armed might of the Soviet Union, together with the cynical diplomacy of which it is at once the expression and the instrument, is the most serious single factor at the present time. The destruction of Germany has created a vacuum which may be filled by Russia. The sky in the Far East is also overcast, but the danger of any early storm there is infinitely more remote than in Europe. We would do well to remember, however, that Russia is an Asiatic as well as an European nation, and if she is checked in Europe she may begin to cast about in other areas for new spheres of influence.

There Is Some Hope

Against this disturbing background is the fact that the free countries of Europe, almost in the hour of their victory in the last great struggle, began to quarrel bitterly among themselves. However there is now some hope in their recent and growing determination to work for their common safety.

In this connection it should be stated, and I am afraid I can only do it most inadequately, that the free world will never cease to be grateful for the unprecedented and courageous initiative being shown by the United States to protect freedom wherever it is being challenged. This is a debt which free men everywhere will always be proud to acknowledge.

The long search for disarmament by the peace-loving nations of the world in the interwar years, while Germany secretly armed for a new war of aggression, can now be seen by every one as one of the supreme mistakes of history. Fortunately, there is no disposition to repeat that mistake at this time. One must, with regret, recognize that the hour for disarmament has not arrived. There is much work to be done and much disarming of prejudices to be achieved before armaments can be reduced.

The democratic world is strong, and it intends to remain strong, not because it wishes to intimidate other nations but because it is determined that it will not be bullied into the surrender or abridgment of its freedom by any power on earth. The people of the United States have shown by their actions how resolute and widespread that conviction is in this country. I believe that the vast majority of the Canadian people share that conviction to the full.

One of the recent developments concerns the formation of the Western European Union. You will recall that on March 17th President Truman indicated the willingness of the United States to do all in its power to protect the signatories of the Brussels 5-power treaty—Britain, France, Belgium, Holland, and Luxembourg—against aggression.

Canada Recognized Pact

That same day in the Canadian Parliament Prime Minister Mackenzie King recognized the Brussels pact as a system of regional security as contemplated by the Charter of the United Nations in defense of freedom, and issued this significant pledge, which has not been challenged by any political party in Canada:

"The peoples of all free countries may be assured that Canada will play her full part in every movement to give substance to the conception of an effective system of collective security by the development of regional pacts under the charter of the United Nations."

That pledge was reaffirmed in the strongest possible terms by the Minister of External Affairs a month later.

In making these pledges our governmental spokesmen were not speaking idly. During the second great war, even with our very slow start, Canada became one of the important sources of military stores. The production in dollar value [shown in detail on page 114] made a total of nearly $10,000,000,000 which, on a per capita basis, I believe was not surpassed by any of our allies.

These figures are not recalled in any spirit of pride or boasting. We were all in the war, and it was our simple and inescapable duty to promote the most decisive victory at the earliest possible moment. But that record has given us, in our country, a certain feeling of confidence that if freedom is ever challenged again we will be able to make a significant contribution.

In recalling this accomplishment we freely acknowledge that two of the most important factors in it were the Ogdensburg Agreement—setting up the

Joint Permanent Defense Board between your country and ours and thereby eliminating all possibility of friction and misunderstanding—and the Hyde Park Agreement, by which you made use of some of our manufacturing facilities and thereby enabled us to integrate our industry more closely with yours. This agreement, incidentally, played a large part in solving an embarrassing exchange situation at the time.

While we are confident that if trouble comes we can do our share, we have one further very great source of strength, and that is that we have only one neighbor—and in our view we have the very best neighbor in the world today!

It is our intention and our hope that we will prove to you that we are the most dependable and best ally that you can have in any time of emergency!

Wartime Know-How Threatened

About eighteen months ago, when we realized that the Department of Munitions and Supply was dismantled and that the armed forces were very largely demobilized, certain officers of the reserve and certain former officials of the Department of Munitions and Supply were fearful that the experience that we had gained at such great cost in our productive efforts during World War II would be lost unless some vehicle were created which would enable the continued association of those primarily responsible for the design, development, and production of warlike stores.

In studying this problem we learned that you had been faced with a similar situation after World War I and had solved it by the creation of the American Ordnance Association. I would like now to express our gratitude and appreciation for the encouragement, advice, and inspiration which your Association has rendered to the Canadian Ordnance Association in our formative stages through the kind offices of my good friend Col. L. A. Codd.

"It is our intention and our hope that we will prove to you that we are the most dependable and best ally that you can have in time of emergency!"

While our association is young and has experienced the usual growing pains, we have certain achievements to our credit. Due in some measure to our activities, our Government has created an Industrial Defense Board. This is an official body which acts in an advisory capacity to the Cabinet. Among its terms of reference are the following:

"To prepare and keep up to date a plan for industrial production in the event of war;

"To arrange for such liaison between the naval, military, and air forces of Canada, the Canadian Ordnance Association, Canadian Arsenals Limited, and other agencies and industries as will ensure an understanding of defense needs and the active coöperation required to meet such needs;

"To encourage the standardization of specifications and industrial practices."

I am informed by my friend, Mr. Harry Carmichael, the recently appointed chairman of the Government Board, who was the Coördinator of Production during the war, that his board intends to use the various committees of the Canadian Ordnance Association to investigate and report on their problems.

We welcome this opportunity for service, but, like your own great Association, the Canadian Ordnance Association is a nonofficial body, and while we are only too happy to undertake any work assigned to us by the Government, our committees will be free to initiate programs and investigations and make recommendations on their own authority without official approval or otherwise. Their recommendations, if they meet the approval of our council, will be submitted to the Government.

We regard this development as of the utmost importance. It is obvious, and I am speaking only of ourselves, that competitive industry, if it is to survive, must constantly improve its methods. No similar stimulant has been available in the past with respect to the improvement of weapons of defense in peacetime. Only under the threat of our own survival have we been willing to devote our best efforts to the improvement of armament.

The Rôle of Private Industry

It is our view that the experience and initiative of private industry, if brought to bear on our defense problems through the medium of our committees in association with the technical officers of the armed services, will be extremely valuable. The field of research is endless, and if we are not to fall into the error of preparing to win the last war we will need to keep on our toes with respect to new scientific developments and study their possible adaptability to military affairs.

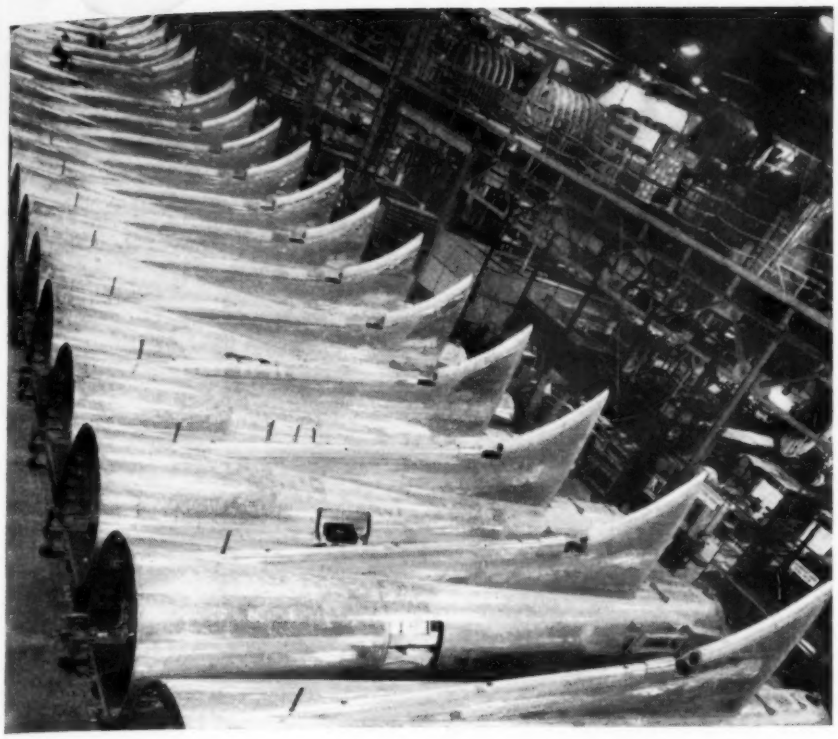
We also have such problems as standardization between your country and ours as well as the continued technical examination of specifications within our own program. We can no longer afford the vast economic waste involved in a multiplicity of specifications.

We must also avoid the stupidity of insisting on a certain specified design which requires retooling at great cost, and perhaps critical delay, when there may be available in commercial production an article which will do the job just as well or better.

It is the happy destiny of Canada to have its future linked with that of the United States. Our common purpose is clear, and our common hope must be that we can keep the New World safe from aggression and assist the Old World to achieve a just and lasting peace. We can accomplish that task if our faith in freedom remains undimmed and our strength is ready to guard and to protect the just cause in which we believe.

Miscellaneous military stores	$1,955,000,000
Mechanical transport	1,818,000,000
Aircraft	1,374,000,000
Gun ammunition	790,000,000
Merchant vessels	732,000,000
Naval vessels	674,000,000
Armored fighting vehicles	609,000,000
Guns and small arms	602,000,000
Instruments and signal equipment, including radar	595,000,000
Chemicals and explosives	516,000,000
Small-arms ammunition	270,000,000
Total	$9,935,000,000

Dollar volume of Canadian military production in World War II.



A Plan for Air Power

America's Aircraft Industry Must Be Able To Meet Mobilization Demands

by

Gen. Joseph T. McNarney

Self-preservation precedes economy and no concession should be made to secondary interests

TO provide meaning and direction to its rôle in solving the problems of mobilizing for war production, industry must know the latest plans and objectives of the services. This cementing of the efforts of industry and of the military services is imperative to assure our national security.

I therefore welcome the opportunity to attend your Thirtieth National Meeting and to describe briefly the significant contribution of industry in helping to develop our Air Force industrial-mobilization planning.

Modern warfare emphasizes mobility and striking force. Space is no longer a barrier to attack. Huge defensive fortresses such as the Maginot Line are antiquated. To survive a future war, a nation must be able to ward off protracted and severe air assaults, shift troops rapidly over thousands of miles, and launch a more vigorous attack of its own.

These conditions emphasize the necessity for air power. To maintain air power requires not only a strong air force in being but also an industry capable of constantly supplying increasing amounts of superior equipment so that the exertion of maximum military effort can continue unabated.

The problem of air power is particularly aggravated by the huge quantities of matériel involved and by the fact that, more than any other industry in the country, aviation has experienced years of unparalleled growth and periods of equally precipitous decline.

At the outset of World War II the American aviation industry was of minor stature, ranking forty-fourth among the industries of the Nation. The dollar value of aviation products manufactured amounted to 280 million.

Within five years the necessities of war catapulted aviation to the rank of the greatest industry in the history of the world. The value of aviation products expanded to over twenty billion—more than five times that of the automotive industry during the year of its maximum peacetime production.

Aviation Hard Hit

The retrenchment of military activities at the close of World War II resulted in the almost immediate reconversion of industry to meet the pent-up demand for civilian goods. Aviation, as was to be expected, was particularly hard hit. Military appropriations were drastically curtailed and the hoped-for civilian market did not materialize. In two years the industry that had dominated the country's wartime economic structure shrank to prewar levels. In 1947, airplane manufacturers produced fewer military planes and employed a smaller number of workers than in 1940, the year prior to Pearl Harbor.

The significance of this condition was highlighted by the President's Air Policy Commission in its historic report issued on January 1, 1948. The minimum Air Force in being recommended by the Commission was 12,400 modern planes, organized into a Regular Establishment of 70 combat groups, plus Guard and Reserve units, plus a reserve of 8,100 aircraft.

General McNarney, Commanding General, Air Matériel Command, U.S. Air Force, delivered this address at the Thirtieth National Meeting of the American Ordnance Association held at the Book-Cadillac Hotel, Detroit, Mich., on June 9, 1948.

These conclusions were strongly confirmed by the Congressional Aviation Policy Board in its survey of national aviation policy released in March 1948. The subsequent developments in the history of the 70-group program and its final approval by Congress and the President of the United States are now well known.

The Air Force has developed production schedules in accordance with this program. These schedules call for increasing levels of procurement until 1953 when production stabilizes at 5,200 planes a year. The weight of these planes is approximately fifteen times the airframe weight accepted in the calendar year 1947, but it is only a step in the direction of the goals that will have to be reached in the event war occurs.

While the 70-group program provides a substantial impetus to the aëronautical industry, the program does not solve the industry's mobilization problems. It does, however, meet the first and perhaps the most important mobilization problem, that is to assure the existence of an expansible industry with adequate manufacturing know-how and the capacity to shift into high-volume production when required.

Strategic Requirements

Another problem is the establishment of strategic requirements. These requirements are divided into two stages. The first and more critical is the production needed during the initial twelve months of war. The significance of this early period arises from the fact that the war may be lost at the outset if industry cannot recoup its strength after the initial impact of an enemy attack and provide sufficient matériel to permit prompt and effective retaliation.

With respect to the aëronautical industry, the minimum requirements during the initial twelve months are equivalent to the level of production necessary to meet and sustain the 70-group program after allowing for wartime attrition rates.

The second segment of the Air Force program carries mobilization requirements from the level existing at the close of the initial twelve months of hostilities to new production goals. As some gauge of the magnitude of these targets, the World War II monthly production peak amounted to 6,805 planes, with an airframe weight of 85,200,000 pounds, attained in approximately 2½ years after December 1941.

The total aim of Air Force mobilization planning is to adopt, in advance, the steps necessary to permit industry to meet these mobilization requirements. The solution to the expansibility problem was turned over to the major aëronautical companies themselves in a series of special contracts known as Phase I studies. The companies were requested to inform the Air Force of the measures that could be adopted, their cost, and the amount of mobilization time they would save.

Analysis of the results of the companies' recommendations revealed that the time-saving measures tended to fall into four basic patterns: production engineering, process engineering, tool design, and tool construction. These summary patterns have since become widely recognized throughout the military services as comprising the basic elements of expansibility.

"Modern warfare emphasizes mobility and striking force. Space is no longer a barrier to attack".

Thereafter the Air Force entered into a series of contracts to determine the ability of the individual companies to meet mobilization schedules. The contracts of this second series are generally referred to as Phase II studies. The contractors were requested to submit their estimated optimum build-up, based on the most limiting internal element, together with the preparedness measures necessary to meet mobilization requirements.

We are now in the process of receiving and evaluating the statements of the manufacturers showing their maximum acceleration potential under wartime conditions.

Our studies have revealed a number of factors which tend to limit the ability of industry to meet acceleration schedules. I would like to cite a few of these. Experimental planes are normally hand-built with maximum performance in mind and with comparatively little emphasis on producibility. As a result, extensive production redesigns are necessary prior to undertaking volume production.

The Air Force and industry have been collaborating in the solution of this problem. At the request of the Air Force, the Aircraft Industries Association has established two working committees—one for airframes and one for engines and propellers—to develop yardsticks by which design proposals can be evaluated for producibility.

Critical materials are a serious bottleneck to production expansion, particularly in the case of new equipment, such as jet engines, that has never been produced previously in large volume.

In order to eliminate this bottleneck the Air Force has let a number of contracts with major engine companies, laboratories, and research organizations. These contracts call for research studies to develop equally effective substitute materials of a less critical nature and for redesign of the engines to minimize use of critical materials.

Important changes in designs of aëronautical items tend to create the need for new types of production equipment and techniques. For example, in order to reduce the weight of planes without impairing the strength of integral parts, modern aircraft tend to incorporate a taper in the thickness of the wing skin.

Engineers at the Air Matériel Command and in industry have been cooperating in the development of new equipment and production methods to eliminate this potential bottleneck.

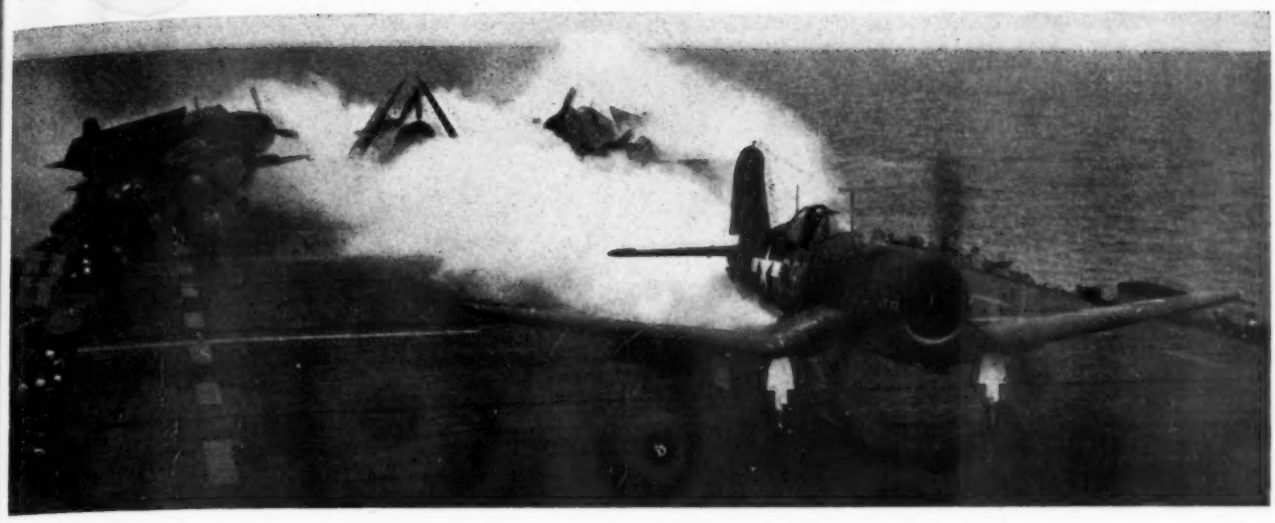
Similarly, in order to obtain maximum tensile properties from magnesium and aluminum alloys the Air Force and industry have been exploring the feasibility of placing greater emphasis on press forgings. In this connection attention is being given to the huge 30,000-ton light-metals forge press developed by the Germans.

Machine Tools Stored

Because shortages of machine tools severely restricted production acceleration during the early months of World War II, the armed forces are selecting and storing surplus machine tools for use in an emergency.

Finally, our mobilization planning is applied to specific airplane models.

A common purpose of the 70-group program and the Air Force mobilization-planning program is the development of an industrial potential capable of maintaining American air power. Achievement of this aim requires the continued coöperation of industry and the military services. Nowhere is this coöperation better exemplified than in such meetings as this. Together we will keep America strong for peace.



The Navy-Army Air Team

American Air Power Must Be a Well-Integrated Force

by

Vice Adm. John D. Price

"The only thing that can be more expensive than an adequate national security is an inadequate one"

TODAY, when one of our most pressing thoughts is the provision of adequate security to our country, it is particularly appropriate that the principal theme of the American Ordnance Association should be the ways and means of promptly achieving the objective of keeping America strong for peace.

Ordnance on land, sea, or in the air is an essential element. We build our aircraft, ships, tanks, guns, and rockets to deliver ordnance against the enemy.

The use in modern warfare by the Army, Navy, and Air Force of technical weapons and the most advanced principles of science readily gains the attention of the public. This must not obscure the vital importance to national defense of the less glamorous and often more arduous rôles of those of you who supply these technical weapons along with those people who are participating so generously in giving this Nation an industrial-mobilization plan.

Preparedness in this age of total war requires the coördinated effort of all elements of our Nation and, in particular, requires the coördinated effort of Government, industry, and the armed services.

The armed services can provide the strategic plans and specify needs; but it is industry which must deliver the goods. Success in any future conflict will depend directly upon industrial capacity, efficiency, scientific progress, and adaptability to defense requirements.

Admiral Price, Deputy Chief of Naval Operations for Air, delivered this address at the Thirtieth National Meeting of the American Ordnance Association at the Book-Cadillac Hotel, Detroit, Mich., June 9, 1948.

Our purely military strength lies in a well-balanced integrated force. Our land, sea, and air forces are mutually dependent.

I like to think of naval aviation and the Air Force as you would think of a boxer. He has two fists, a right and a left. The right fist is for the purpose of the knockout punch. In my opinion, the right fist represents the Air Force—a powerful striking force. But the fighter also has a left fist. With it he delivers left jabs and hooks, keeping his opponent off balance, dividing his defense, making openings for the powerful right. The left fist of the boxer represents naval aviation. We can strike from all angles from a mobile airfield, here today and 700 miles away tomorrow in any direction.

Naval air power, coupled with the 70-group Air Force, can make this country invincible in the air. I have heard talk of the country being "saddled" with two air forces. We are not "saddled" with this advantage—we are blessed with it!

If this country is to survive in the atomic age we need more than emphasis on one arm of service. We need a strong Army, a strong Navy, and a strong Air Force. This will be expensive, but you can't get national security that is worth having today at bargain rates. The only thing that can be more expensive than an adequate national security is an inadequate one!

The State of the Army

Our Strength Now Depends upon Our Equipment Reserves

by

Gen. Omar N. Bradley

Chief of Staff, U. S. Army

"In warfare, ordnance and tactical doctrine go hand in hand."

AT a time when the abundant talents of this great industrial city should be devoted unreservedly to the production of peacetime goods I am dismayed by the tell-tale events that compel me to speak tonight of weapons—weapons we must have to halt the growing fear of war.

For despite our generous aid in relief and reconstruction, the vacuum that might tempt a military adventure in Central or Western Europe has involved us in a struggle where power has once again become the arbiter of decision.

Therefore, even as we continue to strain toward peace through justice, even as we subscribe to the United Nations with the full force of our convictions and with belief in its eventual triumph, we are left with no present-day choice but to arm ourselves if we are to champion its principles as our own.

For if in this period, when power politics have clouded the council chambers of nations, we ignore the needs for competent military strength, we may be forced to abdicate a share of the leadership we bring to the world. And the abdication of vigorous, strong, democratic leadership anywhere at this time can only result in strategic gains for those who would oppose us.

However patient, tolerant, and hopeful we may be, it is clearly apparent that the world cannot find peace if half of us abide by the council table while the other half revert to force. Only when force is rebuffed by force and the risk of retaliation can we hope to demonstrate that international coöperation is not a screen behind which nations may mask their intentions—but that it is instead our best prospective guarantee against world conflagration.

We are in urgent need of time to reconcile these differences that threaten the peace of the world. And preparedness is the price we must pay to purchase this needed time.

As your Army adviser I went reluctantly before Congress on March 25th to recommend an increase in the strength of the Army. For in spite of the alarming dispersal of our forces in occupation duties, in spite of the appalling decay in our combat capabilities, I am readily aware that an increase at this time in military expenditures will not only harass an already overburdened tax system, but that it will absorb critical labor and material needed in the replenishment of the civilian economy.

And I am perfectly aware that further Government expenditures, further competition by the military in civilian markets, will heap additional and dangerous inflationary pressures on top of these unnatural present conditions.

Repair Ground Forces

Yet notwithstanding the critical economic nature of this decision to strengthen our defenses, I could not in good conscience assume responsibility for our share in defense of the Nation without urging the immediate repair of ground-force effectiveness.

It is not the responsibility of your armed forces to predict, to estimate, or to venture the political or even the military intentions of other states. Rather we are concerned with those military capabilities which could be brought to bear in pursuit of national ambitions.

When those military capabilities are overwhelmingly concentrated in the hands of aggressive states, and when they pose a threat to the free and peaceable competition of nations in the political and economic arenas of the world, then we feel it our duty to urge that deterrents be mobilized against the possible use of that force.

I am convinced that the clearly ex-

pressed determination of the American people to repair the inadequacy of their armed forces has awakened the nations of Eastern Europe to full realization of the risks their policies entail. But I am likewise convinced that failure on our part to proceed with resolution in the rearming of our forces could be interpreted only as vacillation or as temporizing in our position.

For that reason if lullabies are to be piped from Europe between the rumbling drums of tension, then the American people must be prepared to discern whether these lullabies mean a change in tempo or in reality a change in heart.

In warfare, ordnance and tactical doctrine go hand in hand, each stimulating the other's development. During the last three years your Army has devoted a share of its annual appropriation to research and the development of test equipment and weapons. Throughout our vast school system we are constantly exploring tactical doctrine to employ to full advantage the results of this research.

Those who would contend that generals always prepare for the last war ignore the unique structure of this American Army school system where thousands of young officers and men are provided avenues for intellectual and scientific inquiry into the techniques and problems of war.

Tactics Must Point the Way

Tactical doctrine, however, must not only absorb and keep pace with the technical advances of American industry, but it must constantly point the way for the design and development of equipment for war.

In any contest of power today American industrial might again holds the decisive advantage. If we can employ this dominance with but a token share of its output in ready machines for war, we can demonstrate that whosoever risks war through aggression must also risk destruction beneath the force of this industrial giant. For Detroit alone is worth a score of divisions on any front.

During recent Washington discussions on the size and character of our armed forces, some observers expressed serious doubts on the ability of the separate services to concur in a joint and effective plan for defense. This speculation was unfounded. The Joint Chiefs of Staff of the armed forces have agreed upon and devised a plan which could be put into immediate action were we attacked tomorrow.

Like all joint strategic plans for defense, it will be subjected to such continuous changes and revisions as further study may require. We anticipate, however, that this emergency plan for defense will soon be so sufficiently hardened that the civilian-governed Munitions Board may proceed with its industrial-mobilization planning.

Contrary to popular belief, the Army does not have sufficient balanced stocks of weapons and other equipment to tide us through industrial conversion in the event of another war. After the defeat of Japan, vast stocks of equipment and matériel were scattered throughout the world. In many instances the cost of transporting these items back to the United States would have exceeded the cost of procurement.

By the end of the war some of this military equipment had already been outmoded, and the rate of obsolescence has accelerated in the last three years. The maintenance of vehicles, weapons, and the vast, complicated matériel of war burdened the Army with an impossible task. Industry could not be asked to manufacture replacement parts for equipment soon to be junked or outdated.

Because demobilization was forced by public opinion into a disorderly rout, the United States not only wrecked the essential pattern of its armed forces, but it discarded and consigned to the junk heap in unmanned bases throughout the world billions of dollars' worth of equipment and supplies. This was the price we chose to pay for expediency, haste, and a quick ticket home.

In addition, the urgent need for prompt reconversion of our war economy produced an early and unavoidable demand for release by the Army of trucks, tractors, bulldozers, construction machinery, and a vast variety of tools and equipment.

Moreover, the power vacuum in Europe and the unsettled internal conflicts in China resulted in a high priority program of military assistance to our wartime allies. This grant to friendly nations consisted primarily of equipment within or near their borders. But at the same time it materially decreased our reserves for postwar forces.

General Bradley delivered this address as the principal speaker at the Thirtieth National Dinner Meeting of the American Ordnance Association, the Book-Cadillac Hotel, Detroit, Mich., June 9, 1948.

This rapid depletion of reserve stocks permitted little planned control. As a result, some categories of supply were crippled worse than others. Consequently, the military value of our existing reserve stocks is limited not only by their inadequate over-all quantities but likewise by their unbalanced composition.

Even with the best advanced planning of civilian consultants to the Munitions Board, and even with the full cooperation of industry, we shall face an irreducible lag of one year or more in the production of munitions in the event of war. Our ability to defend sensitive outposts and to support a limited offensive during that first year of waiting will depend entirely upon our stockpile of equipment reserves. Without this margin of safety, we could conceivably lose a war or certainly prolong a costly conflict—long before our industrial plant could be brought into action.

Strength-in-Being

As the range and power of offensive weapons are increased with each passing year, it becomes more and more necessary for us to bank upon strength-in-being rather than upon our potential reserves. Not only will these annual increments in new equipment create a balanced striking force with the power to provide a deterrent to war, but they will also give to American industry the tooling and production experience essential to effective industrial preparedness.

To those of you who produced the magnificent equipment with which we assaulted the coast of France four years ago this week, I need not repeat that industry has as great a stake in preventing war as it has in winning one. For thirty years your American Ordnance Association has encouraged the armed forces with its appeal for reasonable military strength for national security.

We have in our lifetime the great opportunity to work for peace—or the chance to lose it again through timidity and inaction.

Armament and Production

Past Experience Teaches the Lessons of Preparedness

by

K. T. Keller

"We can look upon our part in the last war as a dearly bought five years of postgraduate education in industrial and military teamwork"

THE job of overcoming the problems which we at Chrysler Corporation met in tank production during the last war was the one in which, when all was done, we had taken the greatest satisfaction. As the first of the great Ordnance projects, this undertaking had a major part in developing the pattern of relationships that guided the Industry-Ordnance team. It set the groundwork for the lasting partnership which we must maintain between the Nation's defense forces and her producing industries.

After we have examined our past experience, we must go on to face the facts that confront us today. One of the first is our mutual responsibility to prevent the necessity of going through the same pioneering stages that we did then in that time of great national danger.

The concern of the Army is to acquire a sharpened perspective on effective ways to get the most out of the industrial machine for military purposes if we must again mobilize the power of the Nation for war. Our concern, on the industrial side, is identical.

We can look upon our part in the last war as a dearly bought five years of postgraduate education in industrial and military teamwork. We should indeed be unworthy if we did not consult this experience freely and very carefully. We must be able to draw from it a great fund of constructive ideas.

It was not only desirable back in 1940, but absolutely necessary, that we state emphatically and clearly certain things which since then have come to be accepted as commonplace.

Principles of Production

Today the first principles of quantity production methods are, I think, understood and accepted quite widely. Not that all the essentials are well understood, but at least the need for time is recognized. The eventual economy of the very costly preparatory planning also is accepted.

Today we in industry know quite a lot about what makes a tank a good one. We have considerable confidence in our ability to contribute to its development once we know the nature of the result desired.

These factors should continue to be true with regard to tanks, airplanes, and all the principal groups of military equipment of today and of the future. They should continue to be true after the men who had the management of both military and industrial operations in the last war have stepped out and have been replaced by another line of command.

It is very encouraging to see what the services are doing, and industries are doing too, to enlarge our education in our mutual problems. The course of study at the Industrial College of the Armed Forces is a case in point as is the program under which officers are stationed in industry to study companies' methods and principles. So is the increasing civilian participation in evaluating and guiding research programs of the services. So is the great effort of the American Ordnance Association which has recognized the equal interest of all the services in industrial preparedness. This has done much to keep the civilian coöperation from being put into too narrow compartments.

These activities are good in themselves, but we must never lose sight of the cardinal principle that activity is only as good as the intelligence brought to it, both by those who present the facts and by those who absorb them for purposes of execution.

If the experience of the last war has left us with a national fixation on a superficial idea, I think it may be the concept of ascribing the successful outcome to sheer mass power mobilized by this country: that massed research made the atom bomb; that massed airplanes and tanks, with their bombs and guns, flattened the resistance of the enemy; that massed industrial machinery made these possible. Here is a plausible idea, but I wonder how far it stands up.

I wonder if General Groves would not state that the application of certain individual intellects and ideas at key places and times controlled the success of the atomic exploration. I wonder if tacticians and strategists will not tell you that mass firepower was only the backstop, important for its availability to retrieve any reverses, and that it was the application of very high quality weapons and leadership in limited, critical situations that achieved success.

Appearances Are Deceiving

Certainly, in appraising industry's part in the war, the appearance of mass is deceiving and dangerous.

It is dangerous because we might some day come to place our confidence in patterns of procedure for mobilization and in the obvious fact that our industries can make a great volume of a great many things when they have the orders and the machinery is ready to roll.

For example, ultimate war requirements broke up the original plan of self-contained manufacture of tanks in our Detroit Tank Arsenal and converted this into an assembly plant fed by eleven Chrysler plants as well as by a multitude of subcontractors. We kept at the arsenal the heavy machining which automobile plants could not handle, but we farmed out all but twenty-two per cent of the value of the arsenal's product. Where at the peak

of production the arsenal had hardly more than 6,000 workers, the tank job in our company as a whole required nearly 25,000 men and women.

When we turned the plant back to the Ordnance Department with the job completed, it had delivered 23,745 tanks of 12 different models and very nearly a quarter of a billion dollars' worth of spare parts, plus nearly fifty million dollars of parts furnished to other tank builders.

That job never could have been done without the trust and coöperation of the top men in Ordnance all the way through. They fought for essential needs when the chips were down. I believe the record shows that we earned their support by making our promises realistic ones and by keeping them without fail. But one does not earn another's intelligence and courage. We were dealing with truly great men.

What can we distill out of this experience that will help in the future?

If we start with first things, we begin, of course, with continuing research. This should be conducted in partnership between the military and those in industry who have the capacity to give effective aid and advice. It should be done with those who, when need occurs, can be depended upon to mobilize not only their own, but a host of associated resources.

We should, I think, be very hard-boiled about the extent and scope of this study and development work. The less there is of lavish or extravagant programs, the more public support we can count on. This will reduce the risk of having the work stopped by misdirected hopes for lasting peace, or by drives for economy in Government which, if properly channeled, still are essential to the country. Those who have this work in hand must confirm and keep the trust of Congress and the public.

Secondly, despite the fact that large military production is not a realistic peacetime prospect—for it would be just as harmful to the services as to the general economy of the country to run up excessive stocks of military items—we must bear down hard to obtain and keep production-mindedness in development and design.

Past experience proved quite conclusively that both development engineers and production men of industry can make very substantial contributions to the design of military items, not only

Mr. Keller, president of Chrysler Corporation and a director of the Michigan Post of the American Ordnance Association, delivered this address before the Industrial College of the Armed Forces in Washington, D. C.

from the standpoint of their manufacture but of their functioning as well. They can make their contribution best if they are taken into the development process before concepts of how to obtain given performances are solidified—while there is still an opportunity to entertain original solutions.

Advance Planning

Thirdly, Government and industry, by advance planning, made an outstanding success of the very difficult and critical job of terminating contracts and clearing plants needed to sustain the civilian economy at war's end. It is a notable fact that this success flowed not from detailed and itemized disposal plans but from writing into law definite statements of the obligations and responsibilities of each party to the transaction.

Much the same thing can be done about mobilization planning. I personally consider detailed advance arrangement as to where and how individual things will be made something of a questionable enterprise. It is very costly and is of limited value because both the demands and ways of meeting them are fluid and changing. No plan filed away today will be very good five years from now. On the other hand, most of the time spent in negotiating contracts could well be saved by advance agreement on the ground rules.

Then we should seek a rigid self-discipline in the matter of design changes during production. We in industry will never question the right of the military authorities to call for a change which will save lives and will meet critical shortcomings. If it plays the devil with productive efficiency, that is one of the costs of war to be borne as well as one may.

But if the time factor is critical and the availability of every essential to production is limited then we must weigh these costs quite carefully because we probably have a smaller margin for waste than we think.

There are two ways to meet the problem. The most constructive is to see essential changes coming and thus provide for their eventual incorporation in advance. That sounds easier to say then to do. Yet, if that attitude is firmly planted, it will be surprising how much can be accomplished in an orderly way despite the sudden twists that campaigns take.

The second way is to question vigorously, and always, the supposed necessity for a change. If it is real it will stand up under honest examination. If it is a whim, lives will be saved and campaigns advanced by laying it aside and keeping the product coming through. Much of this is a problem between procurement agencies and using services, but there is nothing in it that combat officers will not grasp and appreciate once they realize the effects involved.

Next, I would list a very closely related point. We cannot too often stress that volume and efficiency are produced by a steady rate of output, not a jitterbug pace. Twenty-four hours of inefficiency is quite likely to yield less than eight hours properly paced and sustained. An undue rush also dissipates the never too abundant resources of leadership, man power, and equipment.

To turn our requirements on and off with every change in the weather, to heed every smile and every frown of fortune in the field, costs much more in the long run, physically as well as financially, than to adopt a sound schedule and hold to it.

Tests of Character

Unquestionably there should be a medal for bravery for the military procurement officer who sets a proper schedule and then has the courage to stay with it against the clamor and

frantic cries that are sure to surround him. We should never have to sprint production to build political morale through statistics of volume. Possible consequences to individual careers should never dictate overcautious and unwarranted cutbacks. These are stern tests of character which face men who some day may play critical rôles in industrial procurement.

Emphasize Maintenance

Finally, we have entered so deeply into the era of mechanized military action that no emphasis can be too great on the problem of mechanical maintenance and service. The functioning and requirements of the horse and mule were well understood and masterfully cared for in the mounted forces. There was tradition of centuries back of this and there evolved a doctrine and science for the infinite care of the Army's animals. This enlisted not only the thorough attention of the individuals using the animals but also that of a corps of professional specialists.

With mechanical things, we have had far less time to learn. So it is no discredit to say that we have been far less careful and, in a way, less skillful. We have yet to recognize fully the need for specialization in management of mechanical equipment.

With such equipment there is no foraging or living off the land, so the logistical problem is intensified and it runs all the way back to the producing plant. Spare parts must have a place in each procurement program from the stage of original planning. The only way to keep that place from being disproportionate is to invoke a high degree of efficiency in every link from production point to point of use.

Today this chain involves several separate technical services. Each of these has its individual yardstick of effective action and so perhaps one can expect some difficulty in perfecting coördination toward the end result.

Perhaps this is only one of the items in which the rôle of the technician is due an increased recognition in modern military matters. Certainly its characteristics suggest that the day in which the all-around military man can successfully manage specialities may be passing and that still greater recognition and opportunity for promotion to high rank may be due the specialist behind the lines who may not be a combat officer.

I have not attempted to give you a complete catalogue of acts and policies by which the military services may be sure of getting the utmost out of the industrial effort. Rather I have tried to suggest those areas for study and action which most impressed themselves upon us from our experience with tank manufacture—an experience, I shall say again, that gave us very great confidence in the ability and character of the military leaders with whom we worked.

Specific and practical lines for obtaining the best employment of productive resources spread out logically from such items as I have listed.

Today all of us share a considerable concern over the time factor required if it should again become necessary to mobilize our industrial effort. We know it takes twelve, eighteen, or twenty-four months to get production rolling on complex new products. We know the gigantic effort that goes into equipping industry for that production. It does very little good to resolve that we shall be smarter next time, or to declare that we must eliminate the make-ready period.

The national will to arm or not to arm on any given future day is not within our control now. We have no assurances that at the proper time the voters and the country's leaders will be gifted with the supreme wisdom required. We know that beyond preserving a reasonable stock of our present best equipment, it is unrealistic to think of storing up great new armament.

So if we are to make progress, the job has to be broken down into definite sections, each of which can be accomplished and which, one by one, will make a definite contribution to shortening the final make-ready periods and to getting more end product for the effort mobilized.

Let us summarize the several items covered here from just this standpoint of quick mobilization and early return:

First, maintain effective partnership in research. This should be between the services and those sectors of industry that have shown they can contribute effective work. Here you build industry's familiarity with the product far in advance.

Secondly, keep development and design of new items close to the realities of production methods and productive resources. Infinite amounts of tooling and manufacturing time can be saved this way.

Thirdly, define and fix now the ground rules of contract relationships between the armed services and industry. There is no conflict between the true public interest and the true best interests of private companies. It makes no sense to divert time and energy to these things when it is time for action.

Fourthly, recognize as a basic principle that making changes suddenly, after once you start organizing production, wastes enormous amounts of time, material, and man power. This postpones the day when our forces have effective striking power.

Fifthly, economize on the industrial resources of the country by thinking at all times in terms of production rates first. Plan for sustained output rather than round totals.

Sixthly, keep down the drain on production of complete items, which is caused by excessive demand for replacement parts. Recognize what the specialist can accomplish by thorough coördination of all the steps that underlie maintenance and repair of mechanical equipment in the field.

All these add to saving time and getting the most for the effort. Some of the objectives are easier to attain than others, but I am confident that all are within the very great abilities which exist in the country's military services. These abilities are fully equal in their sphere to the best that industry can marshal.

On industry's side you can count on a very great degree of practical cooperation as you move toward specific objectives. We, as well as you, know that the interests of the Nation and of us all require close acquaintance with one another's problems and thinking. We must keep this an everyday affair, not a once-a-year get-together.

In the final analysis real results will come from a relationship founded on mutual respect and understanding of one another's objectives and methods. It can be and must be a strong and effective partnership.

We proved once what that partnership can do. Tank production was just one of its splendid results. It gave us a strong foundation from which we can advance steadily for the greater security of the Nation if we will only see clearly how to build upon it for the future.

Oil and Defense

Petroleum Has Become the Life Blood of Our Armed Forces

by

Leo A. Codd
EDITOR OF ORDNANCE

"Military consumption of gasoline alone in the late conflict was a hundred times that of the A.E.F. in World War I"

FOR modern warfare oil is as necessary as blood. Adequate resources of oil, therefore, are vital in national defense and at the same time they act as a bulwark against war. Kingdoms have been lost because of the lack of oil.

The military machines which the United States developed in two World Wars were geared to the prodigious consumption of oil, and oil contributed importantly to victory in both instances. In fact, the recent world conflict was christened "the war of engines and octanes" by the head of one of the United Nations because of the tremendous amounts of oil needed to fuel and lubricate the variety and quantity of mechanized equipment used on land, on the seas, and in the skies.

More Oil Required

Should the United States become involved in another world war, it is almost a certainty that oil requirements will top those of any previous period in history. That assumption is predicated on the fact that the technological improvements in oil-consuming armaments and equipment in recent years have been such as to discourage the hope that war, in the foreseeable future, would not need greater supplies of oil than ever before—atomic developments notwithstanding.

As in the two previous conflicts, the United States' principal reliance for oil supplies in the future will be on domestic resources which are at the highest level in history. Despite these record reserves, however, supplies probably will have to be augmented from near-by friendly nations in the Western Hemisphere—nations which the United States could protect and to which sea lanes could be kept open against submarine or other warfare. During World War II, a sizable portion of oil was supplied by friendly nations in South America where substantial investments have been made by Americans in the development and production of oil.

Such oil development has been particularly important in Venezuela which today is the second largest producer of oil in the world and the largest exporter. Venezuela played an outstanding rôle as a supplier of oil in World War II, and it probably would occupy a similar position in the event of another conflict in which the United States might become a participant.

The Middle East

The oil-rich Middle East, where Americans also have a big financial stake and where they have been chiefly responsible for development and production of oil on a large scale, is far removed from the United States. Hence in a war, it might not be possible to maintain open sea lanes as easily as to countries in the Western Hemisphere. This would be particularly true if an enemy nation were domiciled close to the area.

The ability of the United States, or of other nations to which it may be allied, to prevent enemy attack on the Middle East and permit continued operation of production, refining, and pipelines, could make that area valuable as a source of supply for fueling ships at the eastern end of the Mediterranean. Several pipelines terminate there. For practical reasons, however, it is doubtful if the Middle East could be of great value as an oil source to the United States for any considerable length of time if an enemy were contiguous to it.

As for the United States itself, it could supply vast quantities of petroleum in another war. Its position has changed, however, since the beginning of World War II. At that time it had a potential productive capacity of almost 1,000,000 barrels a day in excess of its needs. Practically all that slack has been taken up in recent years by a rapid increase in demand for products from the American public, industry, agriculture, and the Government.

Supply and demand were closely in balance during 1947, and in the current year a similar status is indicated. Imports will top exports, it is expected, marking the first time in history that the United States will be an importer on balance.

This change in supply position is principally the result of the industry's inability to expand drilling operations and other facilities on a scale commensurate with soaring product demands

because of wartime and postwar shortages of construction and other materials, especially steel. During World War II, for instance, steel shortages prevented the drilling of an estimated 67,000 wells which would have been drilled under normal conditions.

5,899,000 Barrels a Day

The industry met a record demand for products in 1947 totaling 2,153,433,000 barrels, equal to 5,899,000 barrels a day. That was an increase of 35 per cent compared with the prewar peak year of 1941 and of almost 10 per cent compared with the record war year of 1945 when the industry met a demand averaging 5,358,000 barrels a day—some 540,000 a day less than in 1947. In the current year the demand is expected to establish another new peak, exceeding that in 1947 by about six per cent.

Contributing principally to the increased use of oil in the United States in recent years have been a number of factors: the restoration of motor-vehicle use to a new high, increased and record installations of home oil burners, greater use of Diesel engines, especially by the railroads, and a high level of industrial production and farm income. Moreover, oil requirements of the military currently are seven times the prewar requirements.

To maintain pace with and to keep ahead of the rapidly rising demands for petroleum products, the American oil industry is engaged in a program of capital investments for expansion and modernization of its facilities far in excess of normal. Materials shortages, however, are causing bottlenecks, and construction programs in many instances are being delayed from several months to two years.

As for the fueling and lubricating of a war, some indications of this herculean task may be had from the experience during World War II. In that war the United States contributed more than 1,000,000 barrels daily in excess of ordinary production to fuel its armed forces and those of the United Nations. At the peak of that war, in the spring of 1945, the military was getting approximately 1,600,000 barrels of products daily, equal then to 32 per cent of the domestic industry's production. Of that total, more than 500,000 barrels daily comprised 100-octane aviation gasoline.

By contrast, the total requirements of *all* the Allies in the last six months of World War I (1918) were less than 180,000 barrels a day, or about 9 per cent of those in World War II.

In the late conflict, military consumption of gasoline alone was one hundred times that of the American overseas forces at the peak of World War I. The Army and Navy had 600 times as many motor vehicles as had the American Expeditionary Forces in Europe in 1918. The Navy and merchant marine had more oil-fueled ships and more tonnage than the combined merchant marine of the world after World War I, when navies were still predominantly coal-fueled. Subsequently, however, they became wholly oil driven.

This shift from coal to oil had a decided advantage. Ships could refuel from oilers or from larger warships at sea. Without such an advantage, the type of sustained operations carried out in the Western Pacific during 1943-1945 would have been impossible. Moreover, a ship which burns oil has at least a forty per cent greater cruising radius than one which burns coal.

"The tonnage of oil products shipped overseas during World War II was almost double that of all other tonnage combined."

More Oil than Arms

The tonnage of oil products shipped overseas during World War II was almost double that of all other tonnage combined. The overseas forces required almost twice as many tons of oil products as of arms and armaments, construction equipment, food, clothing, shelter, medical supplies, and all other materials put together. It took approximately a barrel of petroleum products every three days to send a soldier overseas, to keep him there, and to afford him adequate protection.

While it is impossible to predict what the demand for oil will be in the event of another war, certain developments and technological trends in recent years give a clue for arriving at some fair conclusions as to the direction that demand will take. Perhaps the outstanding development in recent years has been in jet-propelled airplanes. These machines are faster and require considerably more fuel than their predecessors. The jet counterpart for World War II's P-51 fighter plane, for instance, uses from 300 to 500 gallons of fuel an hour. The P-51 consumed about 65 gallons of 100-octane aviation gasoline an hour.

Therefore, if it can be assumed that just as many jet planes are used in another war as there were conventional planes in World War II, the fuel consumption of the jet planes would average almost six times that of their predecessors—assuming also that they are used the same number of hours. For the jet planes alone, fuel consumption would run into several million barrels a day which would compare with the average of 1,500,000 barrels a day of all oil products used during the final phase of World War II.

But there is still another factor to be considered in supplying jet fuels in the event of war, and this could present a problem. It is the rigid specification which might be placed on the fuels by the military. The ideal jet engine, from the standpoint of fuel availability, would be one that could use a variety of light fuels ranging from gasoline and kerosene to tractor fuels. Engine designers could ease the supply problem by providing for this flexibility and thus prevent the possibility of fuel shortages at what might be a critical time.

As for conventional airplanes—those not jet-propelled—developments since the end of the war have been toward larger and more powerful units—which means that greater quantities of fuel will be required than by their predecessors.

High-Octane Gasoline

In addition, new fighter airplanes have been developed to use a special high-octane aviation gasoline known as the 115-145 grade (World War II planes used the 100-130 grade) which gives, respectively, from twelve to fifteen per cent greater load capacity and cruising range.

This relatively new aviation fuel is being made in limited quantities presently, and if a sudden demand should

arise for sharply increased production some manufacturing problems might develop. Such higher demands would require immediate and costly new refinery construction which, in a wartime economy, might be impracticable because of materials shortages.

As against the apparent increases in oil-product demands indicated in another war, there may be some partial offsets from the use of chemically propelled missiles and rockets. These latter might supplant some piloted airplanes in a future war, and to the extent that they may be used there would be a reduction in oil requirements. But they would raise new supply problems for the industry in that the raw-material source for the propellants, with an exception or two, would be petroleum in the form of natural gas. Moreover, there may be problems of manufacture if they should be required quickly in large quantities.

Aside from these possible new and larger demands for oil products, there would be the oil required to fuel the

Navy and merchant marine and the mechanized equipment of the ground forces. The sum of these needs, it is believed, probably would not vary greatly from those in World War II. Other petroleum products needed in a war would include toluene, a basic ingredient in TNT; butadiene for the manufacture of synthetic rubber; special lubricants and greases; chemicals; insecticides; asphalt for roadways and airplane landing fields; medicines; etc. There also would be the oil requirements for "essential" industries of farming and those engaged in the manufacture of materials for war.

Superimposed on all these potential needs for war purposes are the needs of civilians. And here is where serious problems might arise, since the U. S. petroleum industry today does not have the same surplus production that it had at the beginning of World War II. A war in the foreseeable future could mean more drastic rationing of civilians than during the recent conflict—unless the industry in the meantime finds it possible to rebuild a reasonable supply margin above the required needs. Its efforts are being devoted aggressively to this objective.

Some people are inclined to look to atomic energy as the answer to the petroleum-supply problem in the event of another war, but military strategists are more realistic and are unwilling to agree with them. These strategists even today are thinking in terms of the amount of oil that will be needed to face any possible future emergency.

Atomic Energy?

As a source of power to replace petroleum, moreover, atomic energy appears to be many years off. Only recently high Government officials rated atomic energy as a power source upon which the United States cannot place too much dependence.

David E. Lilienthal, chairman of the Atomic Energy Commission, "guessed" a few weeks ago that it would be eight or ten years before even "a usefully practical demonstration plant is in operation" for the production of atomic energy. He added that "even after the scientific and engineering underbrush has been cleared away . . . and a commercially useful plant of some size is in successful operation, there are other barriers that must be overcome before any substantial part of our energy supply—say ten or twenty per cent—comes from atomic energy. We do not see how it would be possible, under the most favorable circumstances, to have any considerable portion of the present power supply of the world derived from nuclear fuel before the expiration of twenty years." Any power produced from atomic energy most probably would be electrical power and would not be portable.

There are several ways by which the country's domestic supplies of petroleum could be augmented. One of these depends on Congressional action and would permit fairly prompt development of tidelands oil areas while the other would take years, besides requiring the investment of billions of dollars.

The measure calling for Congressional approval is a bill which would restore the title to tidelands, or lands in the so-called "continental shelf," to the states as it existed prior to a decision of the Supreme Court in June 1947. That decision placed those lands under Federal control.

Development of the tidelands was proceeding rapidly and with great promise up to the time of the Court's decision, but this development was checked and has been held in abeyance because of title uncertainty. The bill reversing the decision of the Court and restoring title to the states was introduced in both houses of Congress, and subcommittees of the Senate and Judiciary Committees recently reported favorably on it, following extensive hearings in February and March of this year. Congressional action is still pending, however.

The other measure is synthesis of liquid petroleum from natural gas, coal, shale, and tar sands. Such synthesis is more expensive, except for natural gas, and would require the investment of billions of dollars before a sizable industry could be developed.

Both the industry and the Government have been conducting research on pilot plants for synthesis of petroleum liquids from these hydrocarbons, and several plants are now under construction for the conversion of natural gas into oil. By 1951 it is expected that a capacity of approximately 17,000 barrels a day of synthetic fuels from natural gas will be in operation. This capacity, however, will represent only a fraction of the 5,814,000 barrels' daily capacity of the crude oil refining facilities today.

A sudden shift of energies and resources to the construction of large synthesis plants would result in greater supply problems than would result from a gradual and orderly development of this source of supply. Far greater quantities of steel are required to make a barrel of finished products by synthesis from coal than to make an equal quantity of petroleum by traditional industry practices.

Moreover, greater man power is required per barrel of synthetic products, and the capital resources of the industry would be depleted more rapidly in plant construction. The facilities for synthesis from coal, aside from needing a tremendous investment for plants of an appreciable size, would require construction materials which are even scarce under present conditions.

It is evident from this discussion that: (1) in the event of another war in the foreseeable future the United States would need larger quantities of oil; (2) the country's supply position has changed so that there is no longer a surplus as before World War II; and (3) the United States will be largely dependent on its own oil resources and, to some extent, upon those of near-by friendly nations.

Month by Month: A Review of the National Defense Situation

WHAT ABOUT UNIFICATION?

Hanson W. Baldwin, military analyst of *The New York Times,* recently summarized the successes and failures of unification during the past year.

There have been seven major unification accomplishments:

1. The Key West allocation of rôles and missions, or functions, among the services.

2. A completely new military establishment, which provides the mechanism for the better integration of military with foreign policy and which establishes or formalizes agencies, boards, and organizations new to our Government, has been set up and staffed.

3. A rational and logical approach to the making of a coördinated budget has been, in part, worked out.

4. A plan for the presentation of unified legislation to Congress also has been formulated and has been applied in part.

5. A coördinated purchasing system, in which one service buys for or coordinates its purchases with the other services, has been established for some eighty-six per cent of the dollar value of all items purchased by all three services.

6. Studies of many subjects of prime importance to the armed forces are being made. Many of these subjects, such as civilian defense, are receiving for the first time coördinated and objective inquiry.

7. Some consolidations have already resulted from unification.

On the debit side of the ledger, Mr. Baldwin lists the following four failures or weaknesses:

1. No unified long-range strategic plan has yet been evolved. The struggle between the Air Force and the Navy over the employment and control of air power still exists.

2. The present organization is, in many respects, cumbersome and awkward; there are so many time-consuming echelons that it is hard to secure decision. The top-heavy commands and staffs that now exist in the services are notorious.

3. No money has been saved. Unification, to date, is more, not less, expensive than non-unification.

4. Real unification, which is an intangible quality stemming from the heart, the mind, and the spirit—from within, not from without—has scarcely been started.

Such are some of the principal accomplishments and failures of unification. What are its prospects? Good.

Mr. Baldwin points out that we live in an era in which the whole military art is in a state of violent flux and in which the world body politic is shaken by change. We see the future dimly. These facts have complicated the change from a 2-department to a 3-department military structure, a change which would have been, even in normal times, a portentous and difficult one. Yet if one can detach one's self from the crises of the moment and view the situation against the perspective of time, it is clear that unification has produced evolutionary progress.

INDUSTRIAL DEVELOPMENT PLAN

The city of Worcester, Mass., solved the problem of a potential postwar shortage of 10,000 jobs by making available to the small industries of the community the management brains that they probably could not afford to hire.

The local Chamber of Commerce added four experts to its staff. These men were highly qualified in the fields of management, production, sales, foreign trade, and transportation. Their services were offered, without cost, to any business concern in the city.

The Worcester Industrial Development Plan has been a huge success. At the peak of war production 91,000 persons were gainfully employed. Today the city has 90,000 gainfully employed.

Worcester's 659 manufacturers are rendering better service to more customers. Eighty-four new industries have started, employing 2,454 persons with an annual pay roll of $5,600,000.

Industrial-service schemes are spreading to other cities across the country.

DEATH OF A SOLDIER

General of the Armies John J. Pershing, who led the American forces to victory in World War I, lost his long and courageous battle against death on July 15, 1948, at Walter Reed Hospital in Washington, D. C. He would have been 88 on September 13th.

General Pershing had seen the wheel of warfare turn full cycle. He skirmished with Indians on our western frontier in 1886, the year of his graduation from West Point; experienced island warfare in Cuba in the Spanish-American War; learned jungle fighting against the Moros in the Philippines; and engaged in cavalry pursuits of Pancho Villa in Mexico in 1916. Then as commander of the A.E.F. he watched his doughboys slog through the mud of Flanders into the trench warfare and stalemate of the Western Front from which he led them forth to victory in the last great offensives.

After a peacetime tour as Chief of Staff, General Pershing retired from active duty in 1924 and assumed the chairmanship of the American Battle Monuments Commission, a position he held until his death.

Watching from the ramparts in World War II, the aging soldier saw the cycle of war continue its sweep as the bastions of the Maginot Line succumbed to the mobility of the German panzers which were in turn overcome by the greater mobility and firepower of another old Cavalryman, General Patton. And he saw the static defenses at Singapore and Corregidor fall, only to be followed by the island warfare and jungle fighting of the Pacific campaign, with the Stars and Stripes again emerging, tattered but victorious, from the battle smoke.

The country mourns the passing of her First Soldier, John J. Pershing. He was a glowing symbol of American might and American manhood.

DEFENSE AGAINST COMMUNISM

A subcommittee of the House Committee on Foreign Affairs recently submitted to the Congress a report on the strategy and tactics of world Communism.

The report summarizes the factors and some of the more important events which have followed the beginning of a Communistic régimé in Russia. After an examination of all aspects of Soviet and Communistic policy and tactics, the subcommittee found that they lead di-

rectly to ten fundamental conclusions:

1. The Communists have one goal—world revolution.

2. They assume that the revolution will be violent.

3. They are incapable of accepting the idea that peace can endure from now on, and they expect one more catastrophic war.

4. The Soviet Union is regarded as the main force of the revolution.

5. They fear a coalition against the Soviet Union.

6. They therefore fear reconstruction or federation in the non-Communist world.

7. They utilize the most modern and effective means of cold warfare to strengthen their own forces and to weaken all others.

8. The Communist parties outside the Soviet Union are junior partners or auxiliaries.

9. The tactics are based upon a definite theory, and the central propositions of that theory do not change.

10. The division of Europe and Asia between the victors of World War II is to be settled by power politics and not by negotiation.

In the opinion of the subcommittee, the recent action by the Congress in providing the means for augmenting the military and naval strength of the United States to meet the challenge of Communistic ideology, when considered seriously, may prove in the years ahead to be the best national-security legislation ever to be placed on the statute books in peacetime.

HOOVER GROUP STUDIES DEFENSE

General of the Army Dwight D. Eisenhower, president of Columbia University, was the principal witness at the second meeting of the Committee on the National Security Organization. The committee, headed by Ferdinand Eberstadt, is part of the Commission on Organization of the Executive Branch of the Government of which former President Hoover is chairman.

General Eisenhower, who is one of a number of consultants to Mr. Eberstadt's committee which is studying the organization of the National Defense Establishment and its ancillary agencies, spoke to the committee informally for two hours and answered questions.

Other witnesses who testified at the 2-day meeting included Gen. Omar N. Bradley, Chief of Staff of the Army; Gen. Hoyt S. Vandenberg, Chief of Staff of the Air Force; Robert A. Lovett, Under Secretary of State; Dr. Vannevar Bush, Chairman of the Research and Development Board; Allan W. Dulles; and others.

DRAFT LAW PROVISIONS

Secretary of Defense James Forrestal expressed the opinion that practically all the selectees under the new draft will be assigned to the Army, since the immediate personnel requirements of the Navy and Air Force probably will be met by voluntary recruitment under existing procedures.

In order to be of assistance to persons interested in the operation of the Selective Service Act of 1948, the Senate Armed Service Committee has prepared a summary of the provisions of the law.

Every male citizen, and every other male person residing in the United States, who is between the ages of 18 and 26 on the day fixed for his registration, is required to register.

Every male citizen, and every other male person residing in the United States, who is between the ages of 19 and 26, is liable for induction for training and service unless he is eligible for exemption or deferment.

There are two short-term enlistments authorized by the act. First, persons in the 19 to 26 age group are permitted to enlist for twenty-one months, in the Regular Army only. The second applies only to individuals between the ages of 18 and 19, and permits them to enlist for a period of one year.

The number of 18-year-olds who may enlist for the one-year period is limited to 161,000, divided as follows: 110,000 to the Army, 36,000 to the Navy and Marine Corps, and 15,000 to the Air Force.

Enlisted members of the National Guard and other Reserve components may voluntarily request active duty with the Regular forces for a period of twenty-one months.

The minimum score on the classification test has been reduced to 70.

Individuals in the 19 to 26 age group who are inducted for a period of twenty-one months are required to serve subsequently for a period of five years in a Reserve component. During this 5-year period in the Reserve there is no obligation for active-duty service, drills, or classes imposed on this group. An individual may shorten this 5-year obligation by (1) enlisting instead for a period of three years in an organized unit of the Reserve components (which would require regular attendance at drill or at classes) or (2) by remaining with the Regular services on active duty for an additional year.

A similar Reserve obligation is imposed on individuals who voluntarily enlist in the Regular Army for a period of 21 months.

For the 161,000 one-year enlistees, a Reserve obligation of 6 years is required. During this 6-year period these individuals are subject to recall for not to exceed one month annually for active-duty training. If a vacancy in an organized unit of the Reserve component should become available, the one-year enlistee is required to fill such vacancy, and in so doing his 6-year obligation is reduced to four years.

This requirement that he should fill an available vacancy in an organized unit is mandatory, subject to relief in case of undue hardship. In the event the individual declines to accept appointment to a vacancy in an organized unit, he may be recalled to active duty in the Regular forces for a period of not to exceed twelve months.

Persons enlisting or persons inducted under this law receive the same pay and allowances as are now current for members of the active forces. However, the act does not provide for any so-called GI benefits.

AIR NATIONAL GUARD

Deliveries of 107 Lockheed F-80C Shooting Stars to the Air National Guard by the U. S. Air Force have begun, and the first 42 of the jet-propelled fighters to be delivered will be sent to Air National Guard units in California, Florida, Maine, Georgia, and Nebraska.

These airplanes, purchased out of fiscal year 1948 appropriations, were assigned to the Air National Guard in line with the Air Force's policy of furnishing the ANG with the most modern aircraft available.

Seventy Air National Guard squadrons throughout the country are now actively participating in weekly flight training. Many units carried out mock tactical missions this past summer during annual field-training exercises.

Spadework for Survival

SOME A.O.A. members didn't make inspirational speeches to overflow audiences in the spacious ballrooms of the Book-Cadillac Hotel at Detroit on June 9, 1948. They didn't give the crowd a thrill during the exciting demonstration of tactical maneuvers and the amazing exhibition of matériel at Selfridge Field the following day. All they did was work.

¶ Some were too tired or too busy to relax with the genial souls of the Cut Back Club on Tuesday evening, June 8, 1948, because they had been hard at it since Monday morning, June 7, 1948. Working, sweating, arguing, accepting assignments, agreeing on solutions of crucial production problems of new ordnance matériel—they were the members of A.O.A. technical committees contributing essential, pick-and-shovel labor of love during the Thirtieth National Meeting of the American Ordnance Association.

¶ Ken Norris, chairman, Cartridge Case Committee, for instance, flew in from Los Angeles to greet an amazing group of sixty-five top-flight engineers and industrialists volunteering to tackle (and solve) the knotty problem of producing completely satisfactory substitutes for brass cartridge cases for Army, Navy, and Air Force fixed ammunition of all calibers.

¶ Ed Ash was on his home grounds in Detroit. As chairman, Rocket Committee, he welcomed a total of ninety-three interested scientists, engineers, and production men and organized them effectively to study the most economical selection of basic materials and the most efficient utilization of production processes—stamping, casting, forging, extrusion, welding—for the prompt production of rockets for the entire Military Establishment.

¶ Rear Adm. Albert G. Noble with his associates in the Bureau of Ordnance, United States Navy, and Maj. Gen. Everett S. Hughes, Chief of Ordnance, United States Army, with his appropriate division chiefs, participated in the discussions, and both expressed sincere appreciation for real assistance received on current production problems. Burton O. Lewis was on hand to keep things moving.

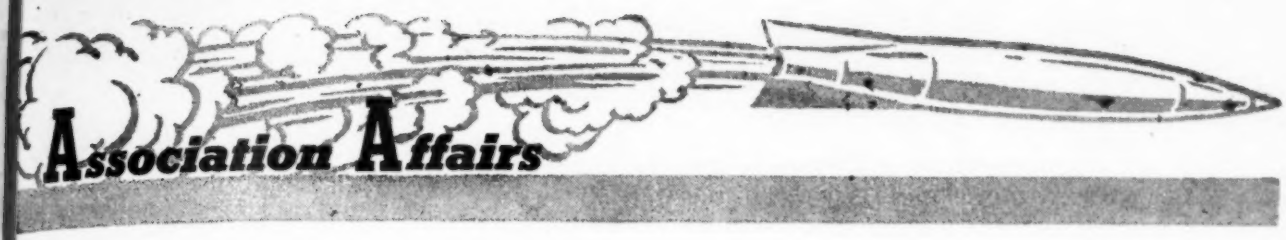
¶ Imaginative concept, meticulous planning, accurate administration, inspirational addresses, renewal of old and making of new friendships, interesting exhibitions—all help to make a National Meeting a success. In the final analysis, however, the real measure of Association accomplishment is its record of production problems solved.

¶ The whole membership of the American Ordnance Association is proud of the selfless devotion to duty of the chairmen and their associates on the various technical divisions and committees organized under the direction of Harvey C. Knowles, national vice-president.

¶ All our people, and peace-loving peoples generally, owe them a debt of gratitude for their successful efforts to keep America strong for peace. They are doing the spadework for survival.

James L Walsh

President, American Ordnance Association.



Association Affairs

PROGRAMS FOR LOCAL POSTS: New Manuals Will Stress Objectives and Organization

Under the direction of Herbert A. Gidney, vice-president in charge of Posts of the American Ordnance Association, there is now in preparation a manual for the guidance of officers and members of all Posts of the Association. It is scheduled to be issued in the fall of 1948. Pending the issuance of the manual, the following salient features of it are outlined for the information of local Post officials:

Objectives.—It is proposed that each Post of the Association set down its specific objectives for the coming year. These might well include:

(1) Coöperation with the United States Army, Navy, and Air Force in all matters for the advancement of their respective programs. For this purpose a Committee on Industrial Preparedness would be advantageous.

(2) Coöperation with other societies and organizations. A Committee on Public Information might well be established to implement the policies of each Post in this regard.

(3) Technical progress. In line with the general purpose of the American Ordnance Association, technical progress as related to the design, production, and supply of military equipment, particularly the production engineering thereof, becomes a prime objective in which Posts of the Association may well participate. To this end a Committee on Technical Progress might be formed by each Post to coöperate with the various technical divisions and committees of the Association and also with scientific and engineering groups within the Post area.

(4) Student activities. The Association will issue shortly a Manual on Student Activities. A prime objective will be the establishment of student chapters in all technical schools and colleges within the Post areas. Alumni of such schools and colleges who are also active in the membership of each Post might well be asked to serve on a Committee on Student Activities.

(5) Meetings and program. A well-considered and properly timed schedule of meetings of Posts throughout the year is essential. A Committee on Meetings and Program could perform this function and the other customary functions of such a committee.

(6) Membership. Both the growth of the Association and the maintenance of its current membership are of prime importance. Local Posts can assist in a very material way in both functions. Hence a Committee on Membership can perform valuable service both in obtaining new members and in maintaining renewal memberships.

Organization.—It is becoming increasingly clear that the proper conduct of the affairs of Posts requires the part-time employment of a secretarial assistant who will maintain the membership records, issue all notices of meetings and activities, and perform such follow-up in connection with the work of the Membership Committees as may be required. Each Post receives fifty cents annually from the dues of each annual member, which is usually sufficient to pay for such part-time employment.

SCHOLARSHIP AWARDS: A.O.A. Medals Presented to R.O.T.C. Ordnance Students

The American Ordnance Association's Scholarship Awards have recently been presented. At the end of the scholastic year in universities and colleges having R.O.T.C. ordnance instruction, A.O.A. medals are awarded to those cadets who are outstanding not only in ordnance but also as students and Americans. These men will be able to assume their proper positions in the Ordnance fraternity to help in creating a strong America for a lasting peace. The institutions presenting the awards and the recipients are:

Agricultural and Mechanical College of Texas: Cadet Maj. Guy R. Norfleet and Cadet Staff Sgt. Wayne B. McLaughlin. Major Norfleet was executive officer of the Composite Battalion Staff and was designated by the college as a distinguished student. Sergeant McLaughlin, a junior in mechanical engineering, has an excellent record in the cadet corps.

University of Oklahoma: Cadet 2nd Lieut. Edward C. Ritchey. Lieutenant Ritchey, a junior studying chemical engineering, was selected as a result of his "outstanding scholastic record as well as his leadership ability and attitude during his R.O.T.C. work."

The Citadel: Cadet Lieut. Kenneth F. Kast, Jr. Lieutenant Kast, a former Air Force gunner and a student of civil engineering, was selected as the outstanding student in ordnance instruction. It was predicted that "he will go far in his chosen career."

University of Nebraska: Cadet 2nd Lieut. James C. Martin. Lieutenant Martin, a junior in the Engineering College, was cited for his superior standing as an ordnance student and for his high scholastic rating in other subjects.

Oklahoma Agricultural and Mechanical College: Cadet Maj. Donald J. Holt. Major Holt, now 2nd Lieutenant in the Ordnance Reserve, received his award for outstanding achievements in ordnance subjects. His engineering studies in electricity have well equipped him for Ordnance Department service.

Virginia Polytechnic Institute: Cadet Pvt. First Class C. R. James, Jr. Private James, in receiving the award, was cited for his "outstanding personal qualifications, demonstrated qualities of leadership, and general excellence in his military and academic subjects."

Stanford University: Willard R. Jarchow. A graduate student at Stanford, Mr. Jarchow has been recognized as the leading ordnance student of his R.O.T.C. group.

Pennsylvania State College: Cadet Gordon L. Morgret. Having served in the U. S. Army overseas during the war, Cadet Morgret is a junior in the School of Mechanical Engineering and an honor student in the Ordnance R.O.T.C. class of 1948.

Michigan State College: Cadet Lieut. Harold L. Robinson. Lieutenant Robinson has not only attained honor grades in his academic subjects but has also been cited as "an outstanding military student," particularly in ordnance fields.

Georgia School of Technology: Cadet 2nd Lieut. Harry E. DeWeese. A first-year advanced student of ordnance, he "has demonstrated oustanding qualities of leadership and ability in performing his duties."

Ohio State University: Cadet James H. Roberts. Cadet Roberts is a mechanical engineering student and a veteran combat infantryman who has attained a superior standing in ordnance subjects.

University of Cincinnati: Cadet Maj. Robert W. Ohlson. A veteran of the Marine Corps, Major Ohlson is an outstanding student of the university, having an academic and military score of 94.8 per cent.

University of Michigan: Cadet Lieut. Col. Lawrence E. Girton and Cadet 1st Sgt. Louis H. T. Dehmlow, III. Colonel

Girton, a fourth-year ordnance student, "distinguished himself by combining an excellent academic and military record with an outstanding list of extra-curricular activities."

Sergeant Dehmlow received the award for the outstanding third-year ordnance student with a superior academic and military record.

NECROLOGY

A. Felix du Pont, Sr., a director, former vice-president, and great grandson of the founder of E. I. du Pont de Nemours & Company and a life member of the American Ordnance Association, died on June 29th at his summer home in Rehoboth Beach, Del., after a week's illness at the age of 69.

Mr. du Pont was born at Hagley, near Wilmington, not far from the site where his great grandfather had built the first powder mill which was the foundation of the widely diversified chemical company that Du Pont is today.

At the turn of the century, Mr. du Pont joined the company as private secretary to his father, Francis Gurney du Pont, then a vice-president. In 1906 he was made superintendent at the Carney's Point plant and in 1911 was transferred to Wilmington as technical assistant on small-arms powder to H. Fletcher Brown, director of the smokeless powder operating department. He was made assistant director in 1914.

In World War I Mr. du Pont served as a lieutenant commander in the U. S. Naval Reserve as an ordnance specialist.

In 1919 he was elected a vice-president and member of the executive committee and placed in charge of the cellulose products manufacturing department. In 1921 he resigned from the executive committee and was appointed assistant general manager of the explosives department in charge of smokeless powder. He was appointed general manager of the smokeless-powder department in 1922 and he retained that position until that department was again consolidated with the explosives department in 1936. He was then appointed to the Finance Committee, having continuously retained the offices of vice-president and director. He retired from the Finance Committee in August 1944 and as a vice-president in 1946.

All members of the Association will mourn the passing of this outstanding American who had devoted his life to better living for Americans in peace and to the greater strength of his country in war.

Colin E. McRae, for many years chief clerk of the Ordnance Department of the Army and a charter member of the American Ordnance Association, died at his home in Dallas, Tex., June 13, 1948. He was well-known and esteemed throughout the Ordnance fraternity both officially and unofficially.

Born in Mt. Holly, Ark., Mr. McRae was commissioned a major in World War I and continued as a member of the Ordnance Reserve Corps. At the time of his death he was a colonel in that component. He was a student of governmental fiscal affairs, and played an important part in the years between World Wars I and II in the preparation of the estimates and the record of appropriations for Ordnance activities, frequently appearing before Congressional committees on these matters.

A charter member of the American Ordnance Association, Colonel McRae helped found the Washington Post and served as its treasurer until his retirement from active service in 1943 when he moved to Dallas. He symbolized the highest attributes of loyalty and industry on the part of that group of civilian employees of the Ordnance Department who were responsible for its steady growth in coöperation with the officers of the Regular Establishment who brought it fame.—L.A.C.

Harry Diamond, chief of the Electronics Division of the National Bureau of Standards and a director of the Washington Post of the A.O.A., died suddenly at his Washington home on June 21, 1948. Mr. Diamond was born on February 12, 190[illegible] and attended schools in and around Quincy and Boston, Mass. He received his bachelor of science degree from the Massachusetts Institute of Technology in 1922, where he served in the SATC during World War I, and took his master's degree in electrical engineering from Lehigh University in 1925.

After Mr. Diamond joined the staff of the National Bureau of Standards as a radio engineer in 1927, his brilliant scientific achievements led to rapid advancement. He was chief of the Bureau's Ordnance Development Division during the war, and later of the Electronics Division, which now includes the ordnance work.

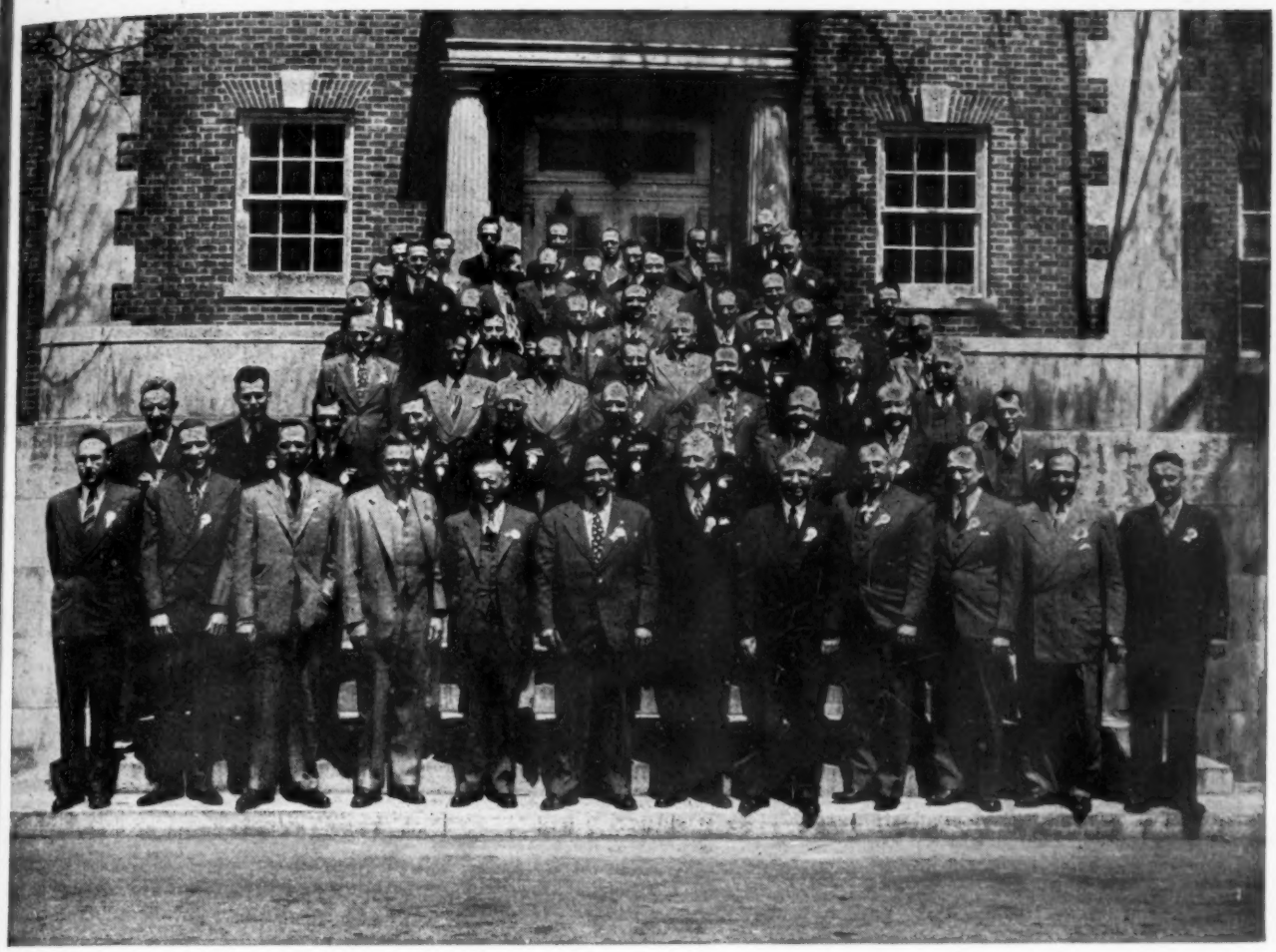
One of the inventors of the radio proximity fuze, Mr. Diamond was widely honored for his work. He also played a large part in the development of the instrument landing system for aircraft and participated in the first completely blind flight and landing of an aircraft in March 1933. Another development of world-wide importance in which he had a major rôle is the radiosonde which automatically collects weather information from the upper atmosphere.

In tribute to Mr. Diamond, Dr. Vannevar Bush, Chairman of the Research and Development Board of the National Military Establishment, said: "The death of Harry Diamond represents a great loss to the scientific world and in particular to the program of research and development for national defense. He was a brilliant scientist and an excellent administrator. His inventions include many which must continue to remain secret in the interests of national security. His leadership in the proximity-fuze program during the war years and his untiring devotion to the programs of military research since the ending of the war will cause him to be remembered always for the resulting achievements. The long hours of work which he spent in the fulfillment of his duties were given without regard to his physical well-being, and this disregard of self may have contributed to his untimely death."

Characterizing Harry Diamond's death as a "great loss to military research," Maj. Gen. E. S. Hughes, Chief of Ordnance of the Army, stated: "The untimely passing of Harry Diamond deprives the Nation of one of its most loyal and valuable scientists. . . . Harry Diamond represented the best in scientific ability. . . . We have lost a great scientific leader, and the Ordnance Department has lost one of its most valued friends and loyal collaborators."

NOTICE also has been received of the deaths of the following members of the Association: G. A. Baker, Grosse Pointe, Mich.; J. C. Bashford, Sea Breeze, N. Y.; H. L. Dibble, Shelby, Ohio; F. S. Dickinson, Rutherford, N. J.; R. C. Forbeck, Terre Haute, Ind.; C. M. French, Fayette, Mo.; M. F. Gardner, Elyria, Ohio; H. A. Gibbs, Jr., San Francisco, Calif.; F. C. Gladeck, Jr., Philadelphia, Pa.; A. E. Goodhue, New York, N. Y.; J. S. Gravely, Stony Creek Mills, Pa.; L. M. Greenstein, Columbus, Ohio; W. D. Hanna, Burlington, Iowa; W. F. Hart, Pittsburgh, Pa.; J. R. Hawkins, Lima, Peru; H. E. Hills, Cleveland, Ohio; George Hunt, Dayton, Ohio; L. L. Kinstler, Detroit, Mich.; C. E. Kramer, Cleveland, Ohio; L. A. Lecher, Milwaukee, Wis.; M. W. Legg, Columbus, Ohio; F. H. Loomis, Cleveland, Ohio; G. L. Merrill, Cleveland, Ohio; G. A. Millard, Hartford, Conn.; Louis Piker, Cincinnati, Ohio; J. K. Priest, Nashua, N. H.; W. S. Quinlan, Springfield, Ohio; F. M. Reedy, Wernersville, Pa.; Harold Rossum, York, Pa.; S. H. Salm, Evansville, Ind.; J. C. Sanders, Cleveland, Ohio; C. E. Schonberg, Covington, La.; J. H. Slater, Cleveland, Ohio; J. J. Strachan, Pittsburgh, Pa.; H. A. Trautman, East Cleveland, Ohio; E. H. Vordenberg, Cincinnati, Ohio; J. E. Weit, Cleveland, Ohio; Harold Wesson, Long Meadow, Mass.; F. R. West, San Andreas, Calif. To their relatives and friends, ORDNANCE, on behalf of the Association membership, extends condolences.

The National Divisions, A.O.A.



The Fuze Committee of the Rocket, Bomb, and Ammunition Division, A.O.A., met recently at Picatinny Arsenal, Dover, N. J. Shown above are members of the committee, the arsenal commander and his staff, and Army and Navy representatives who attended the meeting. Members of the Fuze Committee from industry are in the front row. This was the initial meeting of this committee under the chairmanship of James E. Burke of the Stewart-Warner Corporation, Chicago, Ill.

SMALL ARMS AND SMALL ARMS AMMUNITION DIVISION

C. K. Davis, chairman

On May 13 and 14, 1948, the Rifles and Carbines Committee; the Machine Guns, Belts, Links Committee; and the Pistols and Revolvers Committee of the Small Arms and Small Arms Ammunition Division, A.O.A., held a joint meeting at the Springfield Armory, Springfield, Mass. Col. Morris K. Barroll, commanding officer of the armory, welcomed these technical committees of the American Ordnance Association.

The first day was devoted to an inspection of the manufacturing shops and small-arms laboratory of the armory. On the second day a business meeting of the three committees was held with Col. W. L. Clay, secretary of the Small Arms and Small Arms Ammunition Division, presiding in the absence of C. K. Davis, who unfortunately was unable to be present.

Col. R. R. Studler, chief of the Small Arms Branch, Research and Development Division, Office of the Chief of Ordnance, discussed the trends in development of small arms since the close of World War II. Col. W. L. McCulla, chief, Small Arms Branch, Industrial Division, Office of the Chief of Ordnance, discussed industrial-planning activities pertaining to small-arms matériel.

At luncheon on the second day the members of the three committees met with Stanley C. Hope, president of the Hartford-Springfield Post of the American Ordnance Association. L. A. Codd, executive vice-president of the Association, gave an extremely interesting account of his recent visit to the European theater with a group of newspaper men who were guests of the Army. E. B. Gallaher, author of the AMERICAN ORDNANCE LETTER, also addressed this meeting, covering in a most comprehensive manner the present business outlook in the United States.

On Thursday, May 20, 1948, the Small Arms Ammunition Committee of the Small Arms and Small Arms Ammunition Division, A.O.A., held its initial meeting at Frankford Arsenal, Philadelphia, Pa. Brig. Gen. E. E. MacMorland, commanding general of the arsenal, greeted the committee and their guests. E. C. Hadley of Remington Arms, Inc., was chairman.

INDUSTRIAL MOBILIZATION COMMITTEE

National Headquarters of the American Ordnance Association was requested on June 28, 1948, to review a tentative draft of "Statement of Contract Cost Principles" now under consideration by the Procurement Policy Council of the Munitions Board of the National Defense Establishment. Copies of this draft were furnished to members of the Industrial Mobilization Committee for their comments and recommendations. The changes recommended by the Committee were contained in a report submitted to the chairman of the Joint Army-Navy Audit Coördination Committee on July 16, 1948.

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NEW ATOM WEAPONS

It has been revealed that "three atomic weapons, each of improved design" were successfully tested recently at Eniwetok Atoll in the Marshall Islands.

David E. Lilienthal, chairman of the Atomic Energy Commission, also disclosed that more than 10,000 persons were involved in the project.

The joint task force was commanded by Lieut. Gen. John E. Hull, who told a press conference the tests proved "how bombs now under development by the United States should work."

President Truman's announcement of the tests, which he said "indicate very substantial progress," followed a personal report to him by members of the AEC.

ATOMIC ENERGY LABORATORY

The United States Atomic Energy Commission will establish a chemical laboratory in New Brunswick, N. J., to provide precise analytical quality control of special materials used in the national atomic-energy program. To be known as the New Brunswick Laboratory, the new AEC installation will provide facilities for quality control of material processed in plants under the supervision of the AEC's New York office. Operations under that office include the processing of uranium, beryllium, and other ores and materials of importance in the development of atomic energy.

PATENT COMPENSATION

Regulations governing procedures on applications for the determination of just compensation, a reasonable royalty fee, or the grant of an award under the Patents and Inventions Section of the Atomic Energy Act were published on June 24, 1948, in the *Federal Register* by the U. S. Atomic Energy Commission.

Under the proposed regulations there will be a preliminary examination of all applications by the Commission staff, and provision is made for prehearing conferences to simplify or clarify the issues. Applicants have the right to be represented by counsel. The Board will afford each applicant an opportunity for a hearing at which evidence can be presented, in accordance with generally accepted procedures. The Board may permit oral argument at the close of the hearing and will permit the parties to submit briefs and proposed findings. The Board then will prepare proposed findings to which the parties may file objections. After consideration of any such objection the Board will render a final decision on the entire record, together with a statement of its reasons determining the reasonable royalty fee, amount of just compensation or the amount of award, as the case may be.

URANIUM 233 FISSIONABLE

The isotope Uranium 233, and any material artificially enriched thereby, constitutes a fissionable material within the meaning of the Atomic Energy Act of 1946, the United States Atomic Energy Commission has announced. As defined in the act, the term fissionable material means plutonium, uranium enriched in the isotope 235, or any other material which the Commission determines to be capable of releasing substantial quantities of energy through nuclear chain reaction of the material.

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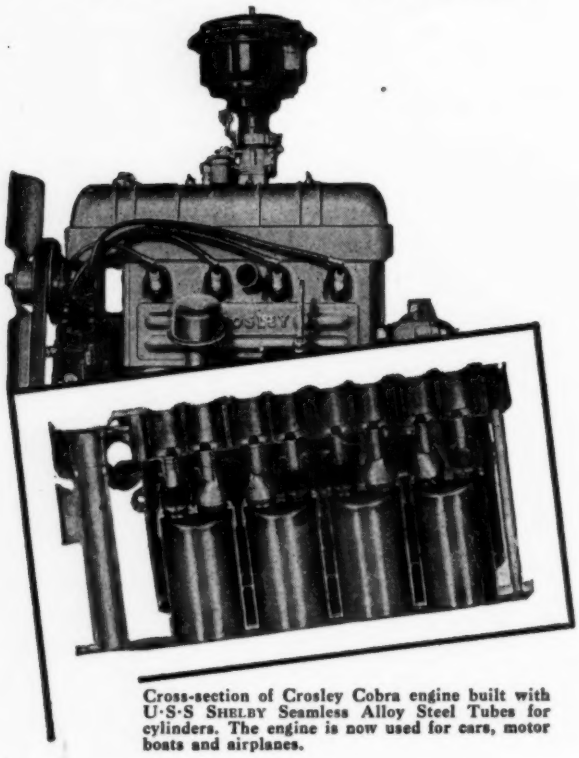

Cross-section of Crosley Cobra engine built with U·S·S Shelby Seamless Alloy Steel Tubes for cylinders. The engine is now used for cars, motor boats and airplanes.

Sometimes a fresh viewpoint helps you solve a problem that has baffled you for months. That's what happened to the designer of this Crosley Cobra engine. To get rid of dead weight, he conceived the idea of building the engine block from steel tubes and steel stampings bonded together in an inseparable whole.

The Cobra has been called one of the outstanding advances in 40 years in internal combustion engine design. Because of its construction, each part can be inspected separately and tolerances rigidly controlled.

The steel cylinder barrels are made from U·S·S Shelby Seamless Alloy Tubing and their use makes it possible for the engine to develop high compression and high speeds without developing hot spots which cause pre-ignition and loss of power.

The use of seamless steel tubes in place of castings and forgings has cut thousands of pounds of dead weight from mobile equipment and saved millions of pounds of steel . . . but there are still innumerable opportunities for greater savings. It may be that tubular construction can help you solve the problem of greater strength with less weight. Our engineers will gladly cooperate. Write for more information.

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F. W. Foster Gleason, *military historian, ordnance analy editor, Washington, D. C.*

Lieut. Col. Calvin Goddard, *small-arms authority, Toky Japan.*

Maj. Melvin M. Johnson, Jr., *automatic arms expert, invento author, Boston, Mass.*

Brig. Gen. R. H. Somers, *engineer, ballistician, author, edito Dover, N. H.*

Col. Thomas K. Vincent, *artillerist, engineer, author, Gre heim, Germany.*

Dr. John J. O'Connor, *educator, author, editor, Washingto D. C.*

The Gathering Storm. By Winston S. Churchill. Bosto Houghton Mifflin Company. 784 pp. $6.

In these pages of mature and mellow wisdom Mr. Churchi recounts some of the incidents and impressions of the story the coming upon mankind of the worst tragedy in its tumultuo history. He shows how easily World War II could have bee prevented; how the malice of the wicked was reënforced by t weakness of the virtuous; how the counsels of prudence and re straint may become the prime agents of mortal danger; and ho the middle course adopted from desires of safety and a quiet li may be found to lead direct to the bull's-eye of disaster.

Looking to the future, he underscores the absolute need of broad path of international action pursued by many states i common across the years, irrespective of the ebb and flow o national politics.

The stirring narrative begins with the end of World War and concludes, in this initial volume, with Mr. Churchill's as sumption of the great office of Prime Minister just prior t Dunkerque. In recounting the major political and militar events of this incredible twenty-year period (1919-1939), Mr Churchill employs the method of Defoe by adroitly hangi the chronicle and discussion of great events upon the thread o personal experience. If this book is not history, it is most cer tainly a highly valuable contribution to history.

Repeated many times, the theme of this volume is "how th English-speaking peoples through their unwisdom, carelessne and good nature allowed the wicked to rearm."

Pondering the Churchill message we may, at long last, beg to repair some of the errors of former years and thus gover "in accordance with the needs and glory of man, the awful m folding scene of the future."—John J. O'Connor.

On Active Service in Peace and War. By Henry L. Stim son and McGeorge Bundy. New York: Harper & Brother 698 pp. $5.

This is the record of the life and work of one of Americ greatest citizens, statesmen, and administrators, Henry L. Sti

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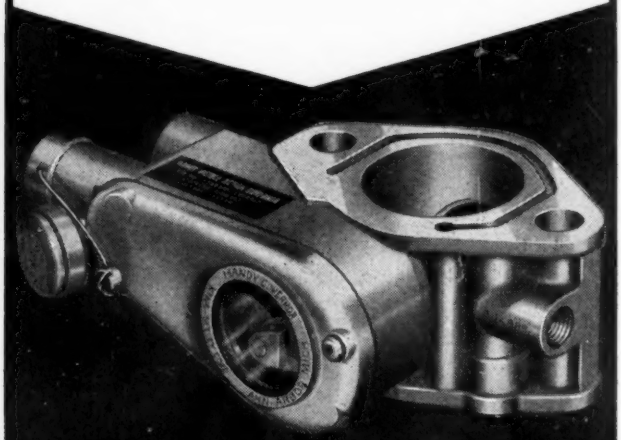

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son. He was Taft's Secretary of War, 1911-1913; Hoover's Secretary of State, 1929; Roosevelt's Secretary of War, 1940-1945; and Truman's Secretary of War, 1945. He was Governor General of the Philippine Islands, 1928-1929. Few men have served their country in peace and in war with greater ability and none with deeper sincerity, prudence, and zeal.

Others will appraise this book in the many fields in which Mr. Stimson served. Perhaps in this magazine we may be entitled to comment on one particular phase of the conduct of World War II—that of military supply. In this regard, many students of the subject—and this reviewer is one of them—contend that the supply job in World War II could have been done at very materially reduced cost in money and with much less damage to the civilian economy.

It is hard to understand why we should have ended the war with a 3½-year supply of bombs and ammunition on hand. This was not a good supply job, and issue can be taken with the Secretary's fulsome praise of the reorganization of the supply setup in 1942 under which such fabulous waste came about.

On the other hand the Secretary describes with forceful logic his wise course when in the midst of the world's greatest conflict efforts were made within the War Department to do away with the technical services of the Army—those time-tried organizations which, in coöperation with American industry, were solely responsible for the design of our superior military equipment.

Secretary Stimson has had close knowledge of ordnance throughout his life. For a period—some twenty years ago—he graciously served as counsel for the then Army Ordnance Association. Nowhere more than in the A.O.A. has he more devoted friends, all of whom will cherish this volume as a mirror of his brilliant mind, his kindly soul, and his always truthful presentation of the case as he saw it.—L. A. Copp.

SMALL ARMS OF THE WORLD—A BASIC MANUAL OF MILITARY SMALL ARMS. By W. H. B. Smith. Harrisburg: The Military Service Publishing Company. 500 pp. $6.

THIS volume, now consisting of 500 pages, was originally compiled to assist our troops in wartime handling of enemy weapons. Now it is of value to the student, collector, dealer, arms analyst, Reserve officer and just plain gun bug. Its simply presented text and nearly 600 photographs and drawings show how to load, operate, and field-strip 150 rifles, handguns, and machine guns of twenty-five nations.

Sections on identification, proof marks, manufacturer's codes, and comparison of foreign and American ammunition are unusually thorough. Smith's comments are entirely free from bias. The marked excellence of many foreign small arms will come as a shock to many an American reader. And he clearly points out the real danger to the ultraconservative American small-arms industry in the remarkably simplified and production-engineered German weapons, processes, machines, and plants now controlled by Russia and her satellites.—F. W. F. Gleason.

THE STILWELL PAPERS. By General Joseph W. Stilwell. Arranged and edited by Theodore H. White. New York: William Sloane Associates, Inc. 353 pp. $4.

THE two most colorful American generals of World War II were George M. Patton and Joseph W. Stilwell. And they are also among the top ten of American tacticians of all time. General Patton's diary was published last year—that is to say an abridgement of it, for more time must pass before its full record dare be disclosed. So it is with Vinegar Joe Stilwell. Only part of his writings are here released, but even these are brutally frank about mice and men. Surely this is the most candid and

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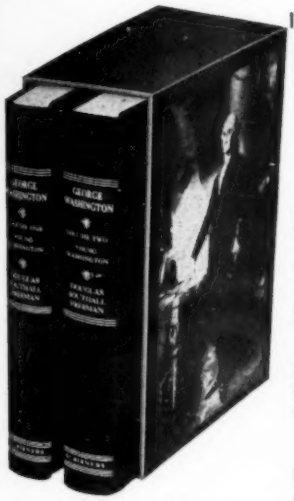

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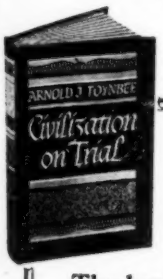

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The Enemy at the Gate. By Maj. Reginald Hargrea Harrisburg: The Military Service Publishing Compa 371 pp. $5.

MAJ. HARGREAVES' volume possesses timely value j now, for military study is going through a phase in wh enthusiasm for the offensive easily loses sight of the defense a scarcely less needful part of warfare. But the work avo narrowness of outlook, for almost as much space—and e more erudition—is devoted to their causes and consequences to the sieges themselves.

The twelve sieges which have been selected for study, fr Rome (410) to Stalingrad (1943) cover a wide range in t and space. In the author's military and political comments vast amount of history is splendidly summarized. And the s cessful historical summary is harder to do—and to find—t the full account.

If Major Hargreaves' military evaluation is very occasiona less than perfect, his sound and salty political satire is pricel The entire volume moves swiftly. Written with succinctness less than with clarity, and rich in pertinent human anecd this is definitely of the newer and more readable school of h tory. Twelve maps and as many illustrations, appendices, a an index round out a worth-while addition to any library F. W. F. Gleason.

The Noncom's Guide. Harrisburg: The Military Serv Publishing Company. 330 pp. $2.

THIS is a ready-reference encyclopedia containing inform tion every noncommissioned officer should know to carry his military duties and administer his personal affairs effectiv All major Army regulations are summarized with admir brevity and freedom from the usual official wordiness. In a tion, more than one hundred other official sources have b digested to provide a usuable and accurate volume of practi military information.

"The Noncom's Guide" begins with a clear explanation Army organization, including an outline of the changes res ing from unification. The next chapter offers a down-to-ea discussion of leadership, morale, and discipline. The leaders section is presented in a practical manner from the junior leade point of view instead of enumerating the virtues of the theore cally perfect leader which are unreal in their high standards.

The duties and responsibilities of key NCO's are described detail, as well as the steps in achieving commissioned rank a the provisions of the new career plan. Subsequent chapters co teaching methods, army schools, courtesy and customs, pay a allowances (with complete pay tables), uniforms and equipme awards and decorations, travel information, National Serv Life Insurance, personal affairs, and veterans' rights.—Ros Emsworth. (*Continued on p. 1*

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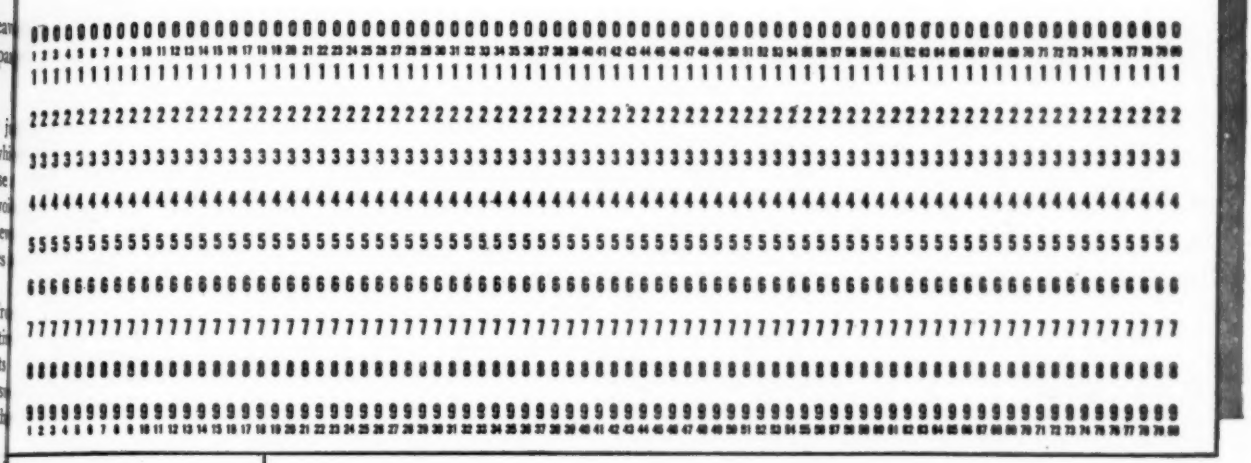

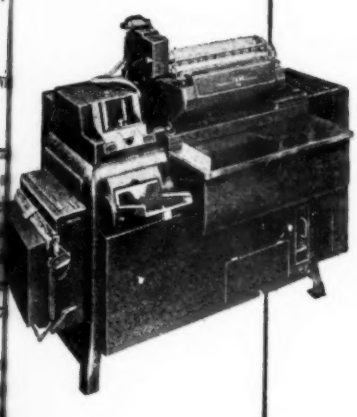

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Book Reviews

FOR WANT OF A NAIL. By Hawthorne Daniel. New Y
Whittlesey House. 296 pp. $3.75.

BENJAMIN FRANKLIN'S clever little doggerel, "For w
of a nail . . . the battle was lost," serves well to point the
nificance of that oft-neglected field of military history—sup
Those books which do more than barely mention the prob
are usually ponderous technical studies that appeal only to
specialist and the serious student.

The author, who served in both the Army and Navy du
World War II, has chosen for his popular-type study on
tary supply six well-known campaigns. These range from Wa
ington's 1776 struggle across New Jersey to the 1944 invas
of Europe. The historical work is richly and thoughtfully don
necessarily condensed, yet avoiding skimpiness.

While Mr. Daniel covers ordnance in a manner which is fa
up to general historical standards, this reviewer cannot but
gret that the author does not give a more detailed picture
weapons. But even to the ordnance enthusiast, as to the m
general reader, "For Want of a Nail" offers some most enj
able reading and much solid and informative history. Four
simple maps and an index add to the worth of the volume.
F. W. F. GLEASON.

JET PROPULSION PROGRESS. By Leslie E. Neville and Nathan
F. Silsbee. New York: The McGraw-Hill Book Compa
232 pp. $3.50.

THIS is a timely presentation of the development of aircr
gas turbines. In simple and accurate terms the authors pres
the absorbing story of the world's most revolutionary pow
plant, the gas turbine. It has potentialities which may one
change the mode of high-speed transportation and power p
duction.

Mr. Neville is a member of the Institute of Aëronauti
Science and director of its Standard Aëronautical Index. Ma
Silsbee is in the Air Reserve, having served with the Air Fo
during World War II. All students of ordnance and its m
applications would do well to familiarize themselves with the
of this volume.—PETER FIELD.

SHOOTING MUZZLE-LOADING HANDGUNS. By Charles T. Haw
Falmouth: Guns, Inc. 132 pp. $4.50.

THE introductory chapter "Modern Shooting Methods," c
taining but 23 pages, holds the real meat—and value—of t
book. To any one who may have occasion or opportunity
shoot the flintlock or percussion pistol or the percussion revol
the instructions, cautions, and unusual tables of this chapter
a necessity. And they are of much value and interest to the
lector or student of such arms.

The bulk of the volume, however, is devoted to the codes
anecdotes of the bygone art of the duel, of interest principa
to the very few whose research might take them into this narr
field.—F. W. F. GLEASON.

BASIC RADIO PRINCIPLES. By Maurice Grayle Suffern. N
York: McGraw-Hill Book Company. 271 pp.

THIS is a manual designed to aid in the training of radio
pairmen and technicians on a vocational-educational level i
period of approximately 200 hours. The basic facts of ra
theory have been expressed as simply as possible. There
been no attempt to approach the higher, technical-education le
involving a knowledge of mathematics and physics. In short
is an excellent manual for the student who has a basic know
edge of the principles of electricity and wants to prepare h
self for radio work.—JOHN J. O'CONNOR.

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Here are inscribed the names of the Company Members of the American Ordnance Association, some of the principal industrial organizations of the United States which are leaders in effecting scientific and industrial preparedness for our security and peace.

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KENNAMETAL, INC. . . . . LATROBE
KENNEDY-VAN SAUN MANUFACTURING & ENGINEERING COMPANY . . . . . DANVILLE
KENWORTH MOTOR TRUCK CORPORATION . . SEATTLE
KEUFFEL & ESSER COMPANY . . . . HOBOKEN
KEYSTONE MANUFACTURING COMPANY . . BOSTON
KIDDE & COMPANY, WALTER . . . . BELLEVILLE
KILGORE MANUFACTURING COMPANY . WESTERVILLE
KING-SEELEY CORPORATION . . . . ANN ARBOR
KINGSBURY MACHINE TOOL CORPORATION . KEENE
KNAPP-MONARCH COMPANY . . . . ST. LOUIS
KOEHRING COMPANY . . . . . MILWAUKEE
KOHLER COMPANY . . . . . KOHLER
KOPPERS COMPANY . . . . . PITTSBURGH

LAKE CITY MALLEABLE IRON COMPANY . CLEVELAND
LANOVA CORPORATION . . . . LONG ISLAND CITY
LANSDOWNE STEEL & IRON COMPANY . . . MORTON
LAPOINTE MACHINE TOOL COMPANY . . . HUDSON
LARGE LUMBER COMPANY, FRED R. . . ROCHESTER
LEBANON STEEL FOUNDRY . . . . . LEBANON
LEE TIRE & RUBBER COMPANY . . . CONSHOHOCKEN
LEEDS & NORTHRUP COMPANY . . . PHILADELPHIA
LEHIGH FOUNDRIES, INC. . . . . EASTON
LIEBERKNECHT, INC., KARL . . . . . READING
LINCOLN BRASS WORKS, INC. . . . . DETROIT
LINCOLN ELECTRIC COMPANY . . . . CLEVELAND
LINCOLN ENGINEERING COMPANY . . . ST. LOUIS
LINE MATERIAL COMPANY . . . . . MILWAUKEE
LINK-BELT COMPANY . . . . . CHICAGO
LUKENS STEEL COMPANY . . . . COATESVILLE
LYNCHBURG FOUNDRY COMPANY . . . LYNCHBURG

MACK MANUFACTURING CORPORATION . NEW YORK
MADDOX FOUNDRY & MACHINE WORKS, INC. . ARCHER
MANSFIELD TIRE & RUBBER COMPANY . . MANSFIELD
MARLIN-ROCKWELL CORPORATION . . . JAMESTOWN
MARMON-HERRINGTON COMPANY . . INDIANAPOLIS
MASLAND & SONS, C. H. . . . . CARLISLE
MASON & HANGER COMPANY . . . . NEW YORK
MATHEWS CONVEYOR COMPANY . . ELLWOOD CITY
MAXSON CORPORATION, W. L. . . . . NEW YORK
MCCAULEY METAL PRODUCTS, INC. . . . BUFFALO
MCCONWAY & TORLEY CORPORATION . . PITTSBURGH
MCINERNEY SPRING & WIRE COMPANY GRAND RAPIDS
MCKAY COMPANY . . . . . PITTSBURGH
MCQUAY-NORRIS MANUFACTURING COMPANY ST. LOUIS
MECHANICAL HANDLING SYSTEMS, INC. . . DETROIT
MELCHOIR, ARMSTRONG, DESSAU COMPANY OF DELAWARE, INC. . . . . RIDGEFIELD
MERCK & COMPANY . . . . . RAHWAY

Honor Roll of Industrial Preparedness

MERGENTHALER LINOTYPE COMPANY . . BROOKLYN
MERZ ENGINEERING COMPANY . . . INDIANAPOLIS
METAL PRODUCTS CORPORATION . . . . . MIAMI
METROLOY CORPORATION . . . . NEW ROCHELLE
MEYER MANUFACTURING COMPANY, GEO. J. . . . . MILWAUKEE
MICA INSULATOR COMPANY . . . . NEW YORK
MICHIGAN STEEL CASTING COMPANY . . . DETROIT
MIDVALE COMPANY . . . . . PHILADELPHIA
MIDWEST PIPING AND SUPPLY COMPANY . ST. LOUIS
MILCO UNDERGARMENT COMPANY . . BLOOMSBURG
MILLER ELECTRIC COMPANY . . . JACKSONVILLE
MILLER MANUFACTURING COMPANY . . . DETROIT
MILLER PRINTING MACHINERY COMPANY . PITTSBURGH
MILSCO MANUFACTURING COMPANY . . MILWAUKEE
MINES EQUIPMENT COMPANY . . . . ST. LOUIS
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY . . . . . MINNEAPOLIS
MINNEAPOLIS-MOLINE POWER IMPLEMENT COMPANY . . . . . MINNEAPOLIS
MISSISSIPPI RIVER FUEL CORPORATION . ST. LOUIS
MONARCH ALUMINUM MANUFACTURING COMPANY . . . . . CLEVELAND
MONARCH RUBBER COMPANY . . . . HARTWELL
MONITOR CONTROLLER COMPANY . . . . BOSTON
MONROE AUTO EQUIPMENT COMPANY . . . MONROE
MONROE CALCULATING MACHINE COMPANY . ORANGE
MONTGOMERY ELEVATOR COMPANY . . . MOLINE
MONTPELIER MANUFACTURING COMPANY . MONTPELIER
MOORE ENAMELING & MANUFACTURING COMPANY . . . . . WEST LAFAYETTE
MOSLER SAFE COMPANY . . . . . HAMILTON
MULLINS MANUFACTURING CORPORATION . . SALEM
MUNCIE GEAR WORKS, INC. . . . . MUNCIE
MUNSINGWEAR, INC. . . . . MINNEAPOLIS
MURRAY OHIO MANUFACTURING COMPANY CLEVELAND

NAGEL-CHASE MANUFACTURING COMPANY . CHICAGO
NARROW FABRIC COMPANY . . . . . READING
NASH ENGINEERING COMPANY . . SOUTH NORWALK
NASH-KELVINATOR CORPORATION . . . . DETROIT
NASHUA GUMMED AND COATED PAPER COMPANY NASHUA
NATIONAL ACME COMPANY . . . . . CLEVELAND
NATIONAL ASSOCIATION OF INSURANCE AGENTS . . . . . NEW YORK
NATIONAL AUTOMOTIVE FIBRES, INC. . . . DETROIT
NATIONAL BROACH & MACHINE COMPANY . . DETROIT
NATIONAL ENAMELING & STAMPING COMPANY . . . . . MILWAUKEE
NATIONAL LOCK WASHER COMPANY . . . NEWARK
NATIONAL MACHINERY COMPANY . . . . TIFFIN
NATIONAL MALLEABLE & STEEL CASTINGS COMPANY . . . . . CLEVELAND
NATIONAL PNEUMATIC COMPANY . . . . RAHWAY
NATIONAL POWDER COMPANY . . . . . ELDRED
NATIONAL SCREW & MANUFACTURING COMPANY . . . . . CLEVELAND
NATIONAL SLUG REJECTORS, INC. . . . ST. LOUIS
NATIONAL STAMPING & ELECTRIC WORKS . . CHICAGO
NATIONAL SUPPLY COMPANY . . . . PITTSBURGH
NATIONAL TUBE COMPANY . . . . . PITTSBURGH
NELSON SPECIALTY WELDING EQUIPMENT CORPORATION . . . . . SAN LEANDRO
NEW BRITAIN MACHINE COMPANY . . NEW BRITAIN
NEW ENGLAND BOX COMPANY . . . . GREENFIELD
NEW ENGLAND BRASS COMPANY . . . TAUNTON
NEW PROCESS GEAR CORPORATION . . SYRACUSE
NEW YORK AIR BRAKE COMPANY . . . NEW YORK
NEWARK STOVE COMPANY . . . . . NEWARK
NIEDRINGHAUS METAL PRODUCTS COMPANY . . . . . ST. LOUIS
NINETEEN HUNDRED CORPORATION . . ST. JOSEPH
NOLL EQUIPMENT COMPANY . . . . CLEVELAND
NORDBERG MANUFACTURING COMPANY . MILWAUKEE
NORRIS STAMPING & MANUFACTURING COMPANY . . . . . LOS ANGELES
NORTHWEST AUTOMATIC PRODUCTS CORPORATION . . . . . MINNEAPOLIS
NORTON COMPANY . . . . . WORCESTER

OAKITE PRODUCTS, INC. . . . . NEW YORK
OCEAN CITY MANUFACTURING COMPANY PHILADELPHIA
OHIO FALLS DYE & FINISHING WORKS . . LOUISVILLE
OHIO RUBBER COMPANY . . . . . WILLOUGHBY
OILGEAR COMPANY . . . . . MILWAUKEE
O'KEEFE & MERRITT COMPANY . . . LOS ANGELES
OLD TRAIL MOTORS, INC. . . . . WASHINGTON
OLDSMOBILE DIVISION, GMC . . . . . LANSING
OLIN INDUSTRIES, INC. . . . . EAST ALTON
OLIVER CORPORATION . . . . . CHICAGO
OLIVER IRON AND STEEL CORPORATION . PITTSBURGH
OLSON MANUFACTURING COMPANY . . . BOISE
OMAHA STEEL WORKS . . . . . OMAHA
OPW CORPORATION . . . . . CINCINNATI
ORLEANS MATERIALS & EQUIPMENT COMPANY . . . . . NEW ORLEANS
OTIS ELEVATOR COMPANY . . . . . NEW YORK
OWENS-ILLINOIS GLASS COMPANY . . . . TOLEDO

PACIFIC CAR AND FOUNDRY COMPANY . . RENTON
PACKARD MOTOR CAR COMPANY . . . . DETROIT
PARISH PRESSED STEEL COMPANY . . . . READING
PARKER RUST-PROOF COMPANY . . . . DETROIT
PARR PAINT & COLOR COMPANY . . . CLEVELAND
PECO MANUFACTURING CORPORATION . PHILADELPHIA
PEMCO CORPORATION . . . . . BALTIMORE
PERFEX CORPORATION . . . . . MILWAUKEE
PFIZER & COMPANY, CHARLES . . . . NEW YORK
PHELPS DODGE COPPER PRODUCTS CORPORATION . . . . . NEW YORK
PHEOLL MANUFACTURING COMPANY . . . CHICAGO
PITTSBURGH STEEL COMPANY . . . . PITTSBURGH
PLUMB, INC., FAYETTE R. . . . . PHILADELPHIA
PLUME & ATWOOD MANUFACTURING COMPANY . . . . . WATERBURY
PLYMOUTH MOTOR CORPORATION . . . . DETROIT
POLORON PRODUCTS, INC. . . . . NEW ROCHELLE
PONTIAC MOTOR DIVISION, GMC . . . . PONTIAC

Honor Roll of Industrial Preparedness

PONTIAC VARNISH COMPANY . . . . . PONTIAC
POPPER, INC., J. S. . . . . UNION CITY
PORTER COMPANY, H. K. . . . . PITTSBURGH
PRENTISS WABERS PRODUCTS COMPANY . . . . . WISCONSIN RAPIDS
PRESSED STEEL CAR COMPANY . . . . . CHICAGO
PROCTER & GAMBLE COMPANY . . . . CINCINNATI

QUALITY GASKET & MANUFACTURING COMPANY . . . . . DETROIT
QUALITY KNITTING COMPANY . . . . . STOWE

RATHBORNE HAIR & RIDGWAY COMPANY . . CHICAGO
RAYNER LITHOGRAPHING COMPANY . . . CHICAGO
RCA VICTOR DIVISION, RADIO CORP. OF AMERICA . . . . . CAMDEN
REEVES BROTHERS, INC. . . . . NEW YORK
REGINA CORPORATION . . . . . RAHWAY
REMINGTON ARMS COMPANY . . . . BRIDGEPORT
REMINGTON RAND, INC. . . . . STAMFORD
REO MOTORS, INC. . . . . LANSING
REPUBLIC STAMPING & ENAMELING COMPANY . . . . . CANTON
REPUBLIC STEEL CORPORATION . . . CLEVELAND
REVERE COPPER & BRASS, INC. . . . NEW YORK
REYNOLDS METALS COMPANY . . . . RICHMOND
REYNOLDS SPRING COMPANY . . . . JACKSON
RHEEM MANUFACTURING COMPANY . . NEW YORK
RICHMOND ENGINEERING COMPANY . . RICHMOND
ROBBINS ENGINEERING COMPANY . . . . DETROIT
ROBERTSHAW-FULTON CONTROLS COMPANY . . . . . YOUNGWOOD
ROSS GEAR AND TOOL COMPANY . . . LAFAYETTE
ROSS-MEEHAN FOUNDRIES . . . . CHATTANOOGA
ROYAL TYPEWRITER COMPANY . . . . HARTFORD
RUDEL MACHINERY COMPANY . . . . NEW YORK
RUSSELL MANUFACTURING COMPANY . . MIDDLETON
RUSTLESS IRON & STEEL DIVISION, ARMCO STEEL CORPORATION . . . . . BALTIMORE

SAE STEELS . . . . . CLEVELAND
SAGINAW MALLEABLE IRON DIVISION, GMC SAGINAW
SAGINAW STEERING GEAR DIVISION, GMC . SAGINAW
ST. LOUIS CAR COMPANY . . . . . ST. LOUIS
SALEM ENGINEERING COMPANY . . . . SALEM
SANDERSON & PORTER . . . . . NEW YORK
SAVAGE ARMS CORPORATION . . . . . UTICA
SCHLAGE LOCK COMPANY . . . . SAN FRANCISCO
SCHLEGEL MANUFACTURING COMPANY . ROCHESTER
SCHLITZ BREWING COMPANY, JOSEPH . . MILWAUKEE
SCHLUETER MANUFACTURING COMPANY . ST. LOUIS
SCHWITZER-CUMMINS COMPANY . . INDIANAPOLIS
SCOVILL MANUFACTURING COMPANY . . WATERBURY
SCULLIN STEEL COMPANY . . . . . ST. LOUIS
SEEGER REFRIGERATOR COMPANY . . . . ST. PAUL
SERVEL, INC. . . . . EVANSVILLE
SERVO CORPORATION OF AMERICA . . LINDENHURST
SEYMOUR PRODUCTS COMPANY . . . . SEYMOUR
SHEAFFER PEN COMPANY, W. A. . . FORT MADISON
SHEFFIELD CORPORATION . . . . . DAYTON
SHELL OIL COMPANY . . . . . DETROIT
SILAS MASON COMPANY . . . . . SHREVEPORT
SIMMONS COMPANY . . . . . NEW YORK
SIMONDS SAW & STEEL COMPANY . . . FITCHBURG
SIMPLEX MANUFACTURING CORPORATION NEW ORLEANS
SINGER MANUFACTURING COMPANY . ELIZABETHPORT
SIVYER STEEL CASTING COMPANY . . . MILWAUKEE
SKF INDUSTRIES, INC. . . . . PHILADELPHIA
SMITH & CORONA TYPEWRITERS, INC., L. C. SYRACUSE
SMITH CORPORATION, A. O. . . . . MILWAUKEE
SMITH, DRUM & COMPANY . . . . PHILADELPHIA
SMITH & WESSON, INC. . . . . SPRINGFIELD
SNYDER MANUFACTURING COMPANY, H. P. LITTLE FALLS
SORENG MANUFACTURING CORPORATION . . CHICAGO
SOSS MANUFACTURING COMPANY . . . . DETROIT
SOUTH CHESTER TUBE COMPANY . . . . CHESTER
SOUTHERN CALIFORNIA PLANT, GMC . SOUTH GATE
SOUTHERN COACH MANUFACTURING COMPANY . . . . . EVERGREEN
SPEED-O-PRINT CORPORATION . . . . . CHICAGO
SPENCER CHEMICAL COMPANY . . . KANSAS CITY
SPERRY GYROSCOPE COMPANY . . . . GREAT NECK
SPICER MANUFACTURING DIVISION, DANA CORPORATION . . . . . TOLEDO
SQUARE D COMPANY . . . . . DETROIT
STANDARD CONTAINER, INC. . . . . MONTCLAIR
STANDARD FORGINGS CORPORATION . . . CHICAGO
STANDARD MOTOR PRODUCTS, INC. LONG ISLAND CITY
STANDARD PRESSED STEEL COMPANY . JENKINTOWN
STANDARD PRODUCTS COMPANY . . . . DETROIT
STANDARD RAILWAY EQUIPMENT MANUFACTURING COMPANY . . . . . CHICAGO
STANDARD STEEL SPRING COMPANY . . CORAOPOLIS
STANDARD TUBE COMPANY . . . . . DETROIT
STEARNS-ROGER MANUFACTURING COMPANY . DENVER
STEEL COOPERAGE COMPANY . . . . . DETROIT
STERLING MOTOR TRUCK COMPANY . . MILWAUKEE
STOCKHAM PIPE FITTINGS COMPANY . BIRMINGHAM
STONE & WEBSTER ENGINEERING CORPORATION . . . . . NEW YORK
STRATFORD ENGINEERING CORPORATION KANSAS CITY
STREICHER DIE & TOOL COMPANY . . . YPSILANTI
STRELINGER COMPANY, CHAS. A. . . . . DETROIT
STUART OIL COMPANY, D. A. . . . . CHICAGO
STUDEBAKER CORPORATION . . . . SOUTH BEND
SUN OIL COMPANY . . . . . PHILADELPHIA
SUPERIOR COACH CORPORATION . . . . . LIMA
SURFACE COMBUSTION CORPORATION . . . TOLEDO
SUSQUEHANNA MILLS, INC. . . . . NEW YORK
SWANK, INC. . . . . ATTLEBORO
SYMINGTON-GOULD CORPORATION . . . ROCHESTER

TALON, INC. . . . . MEADVILLE
TENNESSEE COAL, IRON AND RAILROAD COMPANY . . . . . BIRMINGHAM
TENNESSEE CORPORATION . . . . . NEW YORK
TEXAS GULF SULPHUR COMPANY . . . NEW YORK
TEXTILE MACHINE WORKS . . . . . READING

Honor Roll of Industrial Preparedness

THEW SHOVEL COMPANY . . . . . LORAIN
THOMPSON PRODUCTS, INC. . . . . CLEVELAND
TIMKEN-DETROIT AXLE COMPANY . . . . DETROIT
TIMKEN ROLLER BEARING COMPANY . . . CANTON
TIMMS SPRING COMPANY . . . . . ELYRIA
TITAN METAL MANUFACTURING COMPANY BELLEFONTE
TITEFLEX, INC. . . . . NEWARK
TOKHEIM OIL TANK AND PUMP COMPANY FORT WAYNE
TRAILMOBILE COMPANY . . . . . CINCINNATI
TRICO PRODUCTS CORPORATION . . . . BUFFALO
TROJAN POWDER COMPANY . . . . . ALLENTOWN
TROPIC-AIRE, INC. . . . . CHICAGO
TULSA WINCH DIVISION, VICKERS, INC. . . TULSA
TURNER BRASS WORKS . . . . . SYCAMORE
TWIN DISC CLUTCH COMPANY . . . . . RACINE

UNDERWOOD CORPORATION . . . . NEW YORK
UNEXCELLED CHEMICAL CORPORATION . NEW YORK
UNION CARBIDE AND CARBON CORP. . . NEW YORK
UNION METAL MANUFACTURING COMPANY . CANTON
UNION SWITCH & SIGNAL COMPANY . . SWISSVALE
UNITED AIRCRAFT CORPORATION . . EAST HARTFORD
UNITED-CARR FASTENER CORPORATION . CAMBRIDGE
UNITED CHROMIUM, INCORPORATED . . NEW YORK
UNITED ENGINEERING & FOUNDRY CO. . PITTSBURGH
UNITED METAL BOX COMPANY . . . . BROOKLYN
UNITED MOTORS SERVICE DIV., GMC . . . DETROIT
UNITED SHOE MACHINERY CORPORATION . . BOSTON
UNITED SPECIALTIES COMPANY . . . . CHICAGO
UNITED STATES PIPE AND FOUNDRY COMPANY . . . . . BURLINGTON
UNITED STATES RUBBER COMPANY . . . NEW YORK
UNITED STATES STEEL CORPORATION OF DELAWARE . . . . . PITTSBURGH
UNITED STATES STEEL SUPPLY COMPANY . . CHICAGO

VAN DORN IRON WORKS COMPANY . . CLEVELAND
VANCE COMPANY, J. A. . . . . WINSTON-SALEM
VEEDER-ROOT, INC. . . . . HARTFORD
VERSON ALLSTEEL PRESS COMPANY . . . CHICAGO
VICKERS, INC. . . . . DETROIT
VICTOR MANUFACTURING & GASKET CO. . . CHICAGO
VICTORY PLASTICS COMPANY . . . . . HUDSON
VISKING CORPORATION . . . . . CHICAGO
V-M CORPORATION . . . . . BENTON HARBOR

WAGNER MALLEABLE IRON COMPANY . . . DECATUR
WALTERS MANUFACTURING COMPANY . . OAKMONT
WALWORTH COMPANY . . . . . NEW YORK
WARD LAFRANCE TRUCK CORPORATION . . ELMIRA
WARNER ELECTRIC BRAKE MANUFACTURING COMPANY . . . . . BELOIT
WARNER & SWASEY COMPANY . . . . CLEVELAND
WARREN WEBSTER & COMPANY . . . . CAMDEN
WATERBURY COMPANIES . . . . . WATERBURY
WATERBURY FARRELL FOUNDRY & MACHINE COMPANY . . . . . WATERBURY
WAUKESHA MOTOR COMPANY . . . . WAUKESHA
WEATHERHEAD COMPANY . . . . . CLEVELAND
WEIRTON STEEL COMPANY . . . . . WEIRTON
WELDING ENGINEERS, INC. . . . . NORRISTOWN
WEST TIRE SETTER COMPANY . . . . ROCHESTER
WESTERN ELECTRIC COMPANY . . . . NEW YORK
WESTERN METALCRAFT, INC. . . . . OLYMPIA
WESTINGHOUSE AIR BRAKE COMPANY . . WILMERDING
WESTINGHOUSE ELECTRIC CORPORATION . PITTSBURGH
WETTLAUFER MANUFACTURING CORPORATION DETROIT
WHEELING STAMPING COMPANY . . . WHEELING
WHEELING STEEL CORPORATION . . . WHEELING
WHEELOCK COMPANY, GEO. F. . . . BIRMINGHAM
WHITE MOTOR COMPANY . . . . . CLEVELAND
WHITE SEWING MACHINE CORPORATION . CLEVELAND
WIEGAND COMPANY, EDWIN L. . . . . PITTSBURGH
WILLARD STORAGE BATTERY COMPANY . CLEVELAND
WILLYS-OVERLAND MOTORS, INC. . . . . TOLEDO
WILSON FOUNDRY & MACHINE COMPANY . . PONTIAC
WINCHESTER REPEATING ARMS COMPANY . NEW HAVEN
WINTER-WEISS COMPANY . . . . . DENVER
WIPING MATERIALS, INC. . . . . ST. LOUIS
WIREMOLD COMPANY . . . . . HARTFORD
WISCONSIN MOTOR CORPORATION . . . MILWAUKEE
WOLFE, HARRY M. . . . . CHICAGO
WOLVERINE TUBE DIVISION, CALUMET & HECLA CONSOLIDATED COPPER COMPANY . . . DETROIT
WOOD COMPANY, R. D. . . . . PHILADELPHIA
WOOD MANUFACTURING CO., JOHN . CONSHOHOCKEN
WOOD-MOSAIC COMPANY . . . . . LOUISVILLE
WORDEN-ALLEN COMPANY . . . . . MILWAUKEE
WORLD STEEL PRODUCTS CORPORATION . NEW YORK
WORTHINGTON PUMP & MACHINERY CORPORATION . . . . . HARRISON
WYCKOFF STEEL COMPANY . . . . . PITTSBURGH
WYSONG & MILES COMPANY . . . . GREENSBORO

YORK CORPORATION . . . . . YORK
YOUNG SPRING & WIRE CORPORATION, L. A. . DETROIT
YOUNGSTOWN SHEET & TUBE COMPANY YOUNGSTOWN
YPSILANTI FURNITURE COMPANY . . . . IONIA

ZENITH OPTICAL COMPANY . . . . HUNTINGTON